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HOW TO END THE WAR

PEACE AND PERMANENT PROSPERITY

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How to End the War

By C. J. LAVAL

QUIET has returned to the Port of Shanghai. Although that vast section of the city comprised within the Yangtszepoo, Wayside and Hongkew districts remains closed to the Chinese population and open to only a closely restricted traffic of other residents, some semblance of the former busy appearance of the streets has been restored in the French Concession and in that portion of the International Settlement south of Soochow Creek where the shops, the theaters and the dance halls have reopened, transportation services again are operating and the familiar throngs of Chinese crowd thoroughfares and narrow passages to all intent and appearance indifferent to the encirclement of Japanese bayonets around the entire area that now is under Japanese military domination. Insurance rates have fallen and the flags of foreign shipping again are seen in the harbor of the Whangpoo where lie the grim grey lines of warships, Japanese, American, British, French and Italian, anchored in the stream where they have been through the period of the hostilities around Shanghai. Aside from the immense losses of life and huge destruction wrought by gunfire, incalculable damage to property is left in the wake of the fighting, caused by retreating Chinese forces who applied the torch and left only ashes and desolation behind as they yielded one position after another under the guns of the relentless Japanese advance. Unfortunate refugees, young and old, harried from homes in the war-torn regions, overflow numerous concentration centers and are to be seen wherever they may find space in which to rest weary bodies. Beggars of every degree of wretchedness importune the passer-by. The November sun shines, but the chill trip of winter is on the land.

The Japanese armies have pushed on inland from Shanghai and with the setting sun in their faces are blasting a course westward through one center of population after another on their march toward Nanking and the Yangtze. The Chinese Capital has become a huge military camp occupied only by a defending army awaiting the Japanese onslaught and a depleted Chinese population too poor to be able to shift into places of safety. The Government has been removed far up the Yangtze, to the Yangtze port of Chungking, in Szechuen Province, and all property of value such as Government archives and the thousands of cases containing treasures, removed several years ago from palaces in Peking, have been taken to places of safety in the interior. The handful of foreigners that remained in Nanking have means of swift evacuation in river hulks held in readiness. It was estimated that the Chinese army concentrated to defend Nanking numbers something more than two hundred thousand. The cities along the route from Shanghai to Nanking and around Lake Tai where hitherto Chinese troops have been gathered are in flames or in ruins. Ordinary transport services have vanished and the dirt roadways are deeply rutted from the passage of tanks and mechanized military equipment. The fields and the farms are barren and deserted, for their inhabitants have fled with what scant belongings they could carry in their hands to the unfamiliar inhospitable streets of Shanghai.

All Losses and No Gains

It is all tragically futile, for continuance of this conflict can only mean further repetition of all that has happened at Shanghai, and the ultimate costs to China may become far greater than they have any need to be. A great portion of China's armed strength, built so toilsomely and at such great cost through recent years has been dissipated. The hope that Japan may collapse internally and find herself economically unable to carry on a protracted war is a myth of no substance. The outcome of the recent fiasco at Brussels has made it abundantly clear that China cannot hope even for the imposition by world powers of sanctions, which would harm China as much or more than her adversary. Therefore, armed intervention, that would work out for China's ultimate benefit is beyond possibility. There is Russia, to be sure, and it is true a shadowy possibility exists that Russia may strike. If Soviet Russia should strike and win, then China would only pass into the servitude of the Moscow Soviets. The Chinese temperament is so adjusted in these times, however, and the animosity for Nippon is so deep-rooted, that it is probable that China's radical military leaders would rather have their country become a vassal of Moscow than retain its identity as an independent nation in partnership with the Empire of Japan.

It is true that at the beginning of this struggle China was armed as never before in all her long history, but the world has been marching through the past half century, and China has lagged too far behind to hope within less than a decade to be able to gain the ground lost and win place among the great nations with whom Japan zealously has been keeping step. China's military might in mid-summer, therefore, though great by her own reckoning, was puny when measured by modern standards, and it was quite inadequate for any trial of strength against a modernized military power like Japan. When China went into the conflict, too, her economic resources were at low ebb, and her rural organization, on which she must depend as an agricultural nation, was near chaos. Her commitments abroad and at home with adverse trade conditions at the end of a world depression were such as to render her utterly unfit for any such struggle as has developed. Many of her responsible leaders realized all this and strongly opposed warfare with Japan. It seems to grow increasingly evident that the subversive force that has thrust China into her present plight originally was applied last December at Sianfu when Generalissimo Chiang Kai-shek was captive of rebellious troops under the influence of Communist elements.

For those who talk of a war of attrition that will lead to Japan's ultimate downfall and economic collapse, it may be remarked that through the recent years, in which Japan has been striving to win co-operation from China, she has been industriously preparing for a conflict far different from that which has been thrust upon her in China. These preparations have been going forward for a long while and in recent times Japan has been flexing her muscles while grimly contemplating a clash at arms with the greatest military machine that has ever moved over the face of the earth. It is to be added that the entire Nipponese Nation with no dissentient element solidly is behind the Tokyo Government, and Japan possesses ultimate resources on which she can draw for years, resources that may be replaced as time passes and as those available for present uses are being expended. The world overseas in not yet aware that, whether or not her viewpoint is well-founded, Japan believes that she is fighting for her existence as a nation. This belief has been fostered and crystallized into conviction through the years that have seen the might and the menace of the Russian Soviet grow

in power and influence. Long before Japan's resources are near exhaustion, if China persists in the present struggle, she must inevitably be abased and humbled to a place where her independence as a nation is endangered.

The Conference at Brussels

For China to look to others to help her seems to be a characteristic racial frailty that may have grown from Occidental contacts wrongly interpreted or originally may have been implanted by American missionaries. It followed therefore that China again took her new trouble to the League of Nations, and the physician at Geneva, helpless to heal the hurt, sent the patient on to Brussels. For responsible statesmen to have expected Japan to attend the Brussels Conference inescapably evidences the prevalence of a form of lunacy in high circles. On China's appeal, off-hand, the Assembly of the League of Nations condemned Japan as a treaty violator and as an aggressor. As has happened on other occasions, the League Assembly found itself powerless to deal with the offender. It saw fit, therefore, to nominate another tribunal before which it expected the culprit to appear for castigation. This was done by invoking the Nine Power Treaty, and according to plan the signatories of this treaty were summoned to a Conference at Brussels. Also on urging of the League Assembly they decided to ring the Brussels Town Bell and invite everybody to the trial of the already convicted defendant. So some nineteen Powers sent representatives to Brussels, and they invited Japan to come to the party. The invitation was phrased most discreetly, and no sign of the big stick was permitted to show in the wording. The main count of the indictment against Japan, based on Article 1 of the Nine Power Treaty, charges that she has violated China's territorial integrity. Soviet Russia who despoiled China of Outer Mongolia and since has been playing ducks and drakes with other Chinese territories along the western borders of the country, did not sign the Nine Power Treaty, but Soviet Russia was one of the Powers called to Brussels to sit in judgment on Japan. And they really expected Japan to attend this meeting!

All China's efforts to win help from overseas, necessarily have been moves in the direction of world war, and the clamorous pacifists and uplift bodies on both sides of the Atlantic, without idea or intent of war-making, to be sure, have been demanding imposition of sanctions by governments and this course inevitably would bring on world-wide conflict. It is probable that Japan's overseas trade has been hampered and damaged in some measure by these boycott movements, which have the approval neither of governments nor of responsible organizations. Speaking in October at the Autumnal Conference in Manchester of the Associated British Chambers of Commerce, the President of that body, Sir Geoffrey Clarke, who is Managing Director of the Telegraph and Maintenance Company in his address from the Chair touched on the question of sanctions against Japan.

"As president of the Associated Chambers of Commerce," he went on to say, "I have recently received two cablegrams, one from the President of the Chamber of Commerce and Industry of Japan, and the other from the president of the Japan Economic Federation, inveighing against the malicious anti-Japanese propaganda that is being carried on for the purpose of implanting an uneasy feeling among traders with Japan in this country.

"I need not go into the details of the arguments used to justify their action against China, but I should like to say that if ever there was a time for us to keep absolutely cool and to avoid rash decisions, that time is now. As for the suggestions made to impose sanctions against Japan, surely we have had sufficient bitter experience of the futility of sanctions or boycotts, or whatever term one applies to punitive embargoes upon another country's trade.

"We do not wish to repeat that experiment, and I trust that in our own interests and in the interests of trade generally no such course will be taken."

One Course Open to China

The single hope for China; the course from which she has the least to lose and the most to gain with an end to the conflict lies in direct negotiations with Japan. The present state of affairs is not static. With passage of time conditions are changing and all such change must work adversely for China. Her responsible leaders should ask for terms. Her soldiers have won the admiration of the whole world. No greater acclaim can be added. To persist in hopeless warfare which wise procedure can bring to a halt is nothing less than suicidal. It is much to Japan's advantage, if terms are asked for at this time, to deal generously, and it is to be remembered that Japan's leaders have declared they hold no ill-will toward the people of China.

A hint of what changes may portend if present opportunities are missed was given by General Kazushige Ugaki, one of Prince Konoye's Counsellors, and former Governor-General of Korea. This spokesman said recently that although the Japanese Government still adhered to its declaration that Japan had no territorial ambitions in China, if warfare is prolonged with consequent increase in Japanese sacrifices and casualties, there would necessarily be changes in Japan's national aspirations.

"The ship," he added "may take a course desired by neither Japan nor by China, if China refuses to enter into direct negotiations." The speaker recalled that Japan had sought to hold direct negotiations with China over the Manchurian issue when it developed. "If China had done this in the winter or autumn of that year," he said, "the Manchurian incident might possibly have been settled to mutual satisfaction, but China refused, and the establishment of Manchoukuo was the result."

China is thus left alone embroiled in a war she cannot hope to win. Substantial values are yet to be saved out of the situation, if China will act without hesitancy. If she pursues the futile course of further fighting, none to-day can count the ultimate cost. Undoubtedly in her misfortunes she has the sympathy of a large portion of the outside world, but China should remember that the whole world sympathized with Haile Selassie.

Peace and Permanent Prosperity

By SIR GEORGE PAISH

(In this article is presented the text of an address that was delivered by Sir George Paish, noted British economist, at Washington, D.C., on January 22, 1937)

I AM going to talk to you about "Peace and Permanent Prosperity." I want you to realize, in the first place, how extraordinarily grave the present position is. I believe I am fully justified in saying that never was the world as a whole in a position anything like as grave as it is in to-day. I am fully justified in that. Not even in the days before the Great War, not even in the Great War, because at that time it would have been possible to have brought the war to an end if the governments of the warring nations had decided to bring it to an end. And, therefore, it could have been brought to an end by a relatively few people and the catastrophe would have been over. But to-day the whole world is engaged in pursuing a policy which, if continued, means disaster not for one country only but for all countries without exception.

If you look over the whole field you will discover that as the economic situation becomes more difficult the political situation becomes more difficult. And so you have action and reaction. And as the political situation becomes more difficult, so the economic situation becomes more difficult. You will see how extraordinarily grave the political situation is. In the first place, everyone will recognize that the new policy of rearmament after an endeavor to disarm, is most disturbing. And it is clear that, having regard for the world's policy of rearmament, that the world is definitely on the road to a new war unless there is a change of policy. Those of us

who are old enough, remember the increasing armaments before the Great War, and how some realized that those increasing armaments meant war if they were not prevented from increasing. And while some did try to do what they could to bring about an understanding of the danger, most people had no such understanding. The spark came, the powder magazine blew up, and we had the Great War.

To-day it is clear that the policy of rearmament which the world is now pursuing must eventually lead to war unless there is a change of sentiment, of outlook, and of action.

There is another danger. There is danger of the internal difficulties of the various nations, of the internal distress, leading to revolution. The actual operation of this distress we see in Spain to-day.

That trouble came, in the main, from the great fall in world prices, the great shrinkage in world income, and the great shrinkage in the income of Spain both from agriculture and industry bringing in turn a great reduction in wages coupled with unemployment. The consequent distress of the Spanish people brought into power a government "to the left," which frightened the great landowners and great industrialists and led to the present civil war.

If events move as they are now moving, that situation will be repeated in other countries. If you look at Germany to-day you will see how extremely serious the internal position of Germany is. The reports come over, as you know, that the nation is short of both food and raw material. That has been recognized by the government, recognized by General Goering when he said "better to have guns than butter."

What is going to happen in Germany in the coming spring I do not know with a shortage of wheat, a shortage of fats of all kinds, and a shortage of raw materials. Will it lead to revolution, as in Spain ?

In an internal situation of such gravity it is not unreasonable to infer that Mr. Hitler in increasing his army to 600,000 men had the distress of the German people and the danger of internal trouble in mind. At any rate conscription has come at the very moment when Germany is short of the necessaries of life.

Then you have Italy. I am convinced that Signor Mussolini would never have gone to Abyssinia had it not been for the distress of the Italian people. Italy's income had shown a great decline ; their exports were down to a very small figure ; their tourist income had been greatly reduced, and there were few remittances from Italians working abroad. The result was that Italy was in a real depression. So Mussolini said, "We must do something about it." Moreover it seemed to be obvious, that his own position was in danger. So he attacked Abyssinia in order to maintain the spirits of the Italian people.

May I say that neither of these policies improved the situation. Indeed the creation of a peace army in Germany of something like 600,000 men and the conquest by Italy of an inoffensive country, have definitely made the situation worse not better and by so doing have not improved matters either in Germany or in Italy and the internal situations in both countries give cause for greater anxiety in consequence.

But we must recognize that when nations get into distress they are as likely to act unwisely and foolishly because of their distress as they are to act wisely.

And I would apply that also to the Japanese. The Japanese action in the Far East arose from similar causes. In 1931, when Japan invaded Manchuria, Japan was in distress. The shrinkage in her foreign trade was very great, and the people of Japan were in great economic need. So they took the military steps with a view to keeping up the morale of the people. Consequently vast sums were expended uselessly and the state of the Japanese people has been rendered worse not better.

So I come to this position. The situation to-day is one that is causing everyone in a position of responsibility very great anxiety. Anything may happen, if the difficulties of the world are not adjusted, and the sufferings of the nations are not relieved.

Now, some of you may say to me, "But things have very greatly improved. Unemployment in Germany is not as grave as it was a few years ago. The situation in Japan is better. The situation in the world is better."

True, but one must look to the causes of the improvement in order to discover whether or not those causes are likely to be permanent. Any such examination will disclose these causes to be for the most part temporary. It is evident that in order to create employment and to increase buying power many nations are using up their ultimate reserves first of gold and second of government credit.

The gold reserves of the greater part of the world are almost exhausted. The two or three great credit nations have drained to themselves almost the whole of the world's gold reserve. You here in America have now accumulated a gold reserve of no less than eleven billions of dollars. We in Great Britain have a gold reserve, visible and invisible, of no less than four and a half billions of dollars, and France has gold reserves visible and invisible of unknown amount, but totalling several billions of dollars. The bulk of the world's gold is now accumulated in these three countries. Consequently the world cannot continue to buy and to meet its obligations as it has been meeting them in the past by selling vast quantities of gold.

Now as to government credit. Government credit is really the final reserve of a nation. If there are no other reserves available a nation pledges its credit in order to supply buying power to its people. The governments of the world have since 1931 been pledging their credit on a very large scale. Since the breakdown in 1931 practically every government in the world has been engaged in pledging credit in order to give buying power to its people and in this past year the nations collectively have created upwards of ten thousand million dollars of government credit. Here in America your government has created four billions of dollars of government credit. Your buying power has been increased during the past year because your government has borrowed and spent this great sum. Moreover, your aggregate income has been increased by several times that sum. That was the sum put into circulation and the aggregate amount of buying power has been much greater than the original amount of the credit created.

So it is with Germany. Mr. Hitler has spent very large sums of government credit in the last year. How much is not known. The other day I was talking to a German economist, who, I believe, had the true story. He said Mr. Hitler had borrowed in the past year not less than three thousand million dollars—government credit created to give buying power to the German people. How soon will the credit of the German Government be exhausted ?

If you go to France, you will find the French Government has had to borrow large sums, in order to balance the budget to meet the deficit on the railways and for rearmament. But the sum borrowed has given buying power to the French people which otherwise they would not have possessed. Fortunately the French people still possess large reserves of gold and of credit.

And the Italian Government has borrowed great sums, relative to the wealth of the Italian people.

The Abyssinian campaign has cost Italy a very large sum. How long the Italian Government can continue to borrow I do not know. They are trying to borrow on the security of the wealth they are hoping to get out of Abyssinia but who is likely to furnish Italy with credit under present conditions and if she cannot continue to borrow what is likely to be the condition of the Italian people in the coming months and what will be their political reactions to their distress ?

So you have one country after another using its ultimate reserves to maintain the buying power of its people but how long can that buying power be maintained ?

If you will look over to Japan you will see trouble arising there. The Japanese Government has been borrowing large sums of money for its military expeditions in Manchoukuo and in China and these expenditures have given buying power to the people. The Japanese business men now wish to bring about a reduction of these expenditures. What is likely to happen in Japan ?

Thus the world's recovery has come in large measure because the world has been using its ultimate reserves. The world's buying power has been very greatly increased by the use of these ultimate reserves, and it will be reduced correspondingly if and when those reserves come to an end and are no longer available. And then what ?

You must bear in mind that the economic troubles of the world have come in the main from fear, fear in many nations that they will not be able to support their people. Consequently each one has endeavored to produce as much in their own country as possible and to become as fully self-sufficing as it is conceivable for a nation to be. It is this fear and this policy that are producing the present distress.

Then what is likely to happen ? Is it not likely that that policy will be accentuated if the distress becomes greater ? Will not the

nations say " We cannot afford to buy abroad. We must live on what we ourselves produce ? "

So the distress may become greater and not less. Bear in mind the prosperity of the world in modern times was created by the fact that the nations became more and more interdependent and bought abroad vast quantities of goods and produce of all kinds for their daily needs. It was that interchange of products which created the modern world of interdependent nations. It was that interchange which made it possible for countries to maintain such great populations.

If the policy of self-sufficiency which the world is now pursuing is accentuated, what will be the result ? Great distress and ultimate starvation. Yes privation and starvation in every country for all nations to-day depend for the maintenance of their people upon the foreign trade which has grown to be so important.

Let me give you some sort of notion of how many people in the various leading countries are dependent upon foreign trade. I come to my own country first, Great Britain.

We had only a very small population less than two hundred years ago. It seems impossible that in about 1750 we could have had in Great Britain a population of not more than six million. We now have 46,000,000 people. And that population has increased because there has been this vast expansion of international trade so that we can buy abroad the products that we need to maintain this relatively great population. It is calculated that no less than two-thirds of our people are directly or indirectly maintained by food and raw material which we are able to buy abroad with the income that we get from the world in general from our exports, from the interest on our foreign investments, from our shipping, and from our other services, banking, mercantile, etc.

If world trade breaks down, what in Heaven's name will happen to the British people ? If the world continues to pursue its present policy of self-sufficiency, what will happen ?

Our present position on the whole is satisfactory, or relatively satisfactory. Our home trade has greatly recovered since 1931 due to three causes : First, an immense building boom (we are putting up in Great Britain nearly 300,000 houses per annum mainly by private enterprise) ; Second, from slum clearance which involves the building of another 60,000 houses per annum ; Third and recently, from great expenditures for rearmament.

These three factors combined are causing money to circulate very freely in Great Britain and give us the appearance of prosperity. But those expenditures are not likely to continue indefinitely. Already the building boom is showing signs of decline while slum clearance will go on for a time and so will rearmament.

But, Great Britain cannot be prosperous unless the world is prosperous. It is physically impossible. Great Britain is more dependent than any other nation upon the prosperity of the entire world.

For a century Great Britain has succeeded in obtaining, roughly speaking, 10 per cent of the world's growing income. Because the world's income grew, our income grew in proportion because we pursued a policy which brought to us that percentage. If the world's income shrinks, as it may shrink, if the world trade shrinks under this policy of self-sufficiency and the distress grows great, then our position will become exceedingly dangerous.

Germany, France, Italy—what about them ? Before the war it was calculated that at least one-third of the German population was directly and indirectly dependent upon foreign trade. A vast number of people in Germany, therefore, are dependent upon foreign trade and upon world prosperity.

As to France it is equally true. Practically all of the great towns of France depend for their welfare upon international trade.

And when we come to Italy and to Japan, it is abundantly evident there can be no prosperity in these countries unless the world is prosperous and that were the world's present policy of autarchy to be accentuated, a large percentage of the Italian and Japanese people would be in grave trouble.

Nor is America itself an exception, notwithstanding her vastness and the greatness of her population, for to-day America needs world markets as never before. In the past century America has been developed in a manner and at a speed that are amazing. Vast works of construction, railroads, roads, office buildings, mines, farms, everything essential to prosperity except one thing—the power to sell its products in adequate quantity. You have developed a vast country of three millions of square miles. You have increased your output as no country has ever done before and to-day you have almost unlimited productive power.

To accomplish this feat you have spent capital on a stupendous scale and it was these great capital expenditures which gave you the almost unlimited prosperity you enjoyed while they were being disbursed. But to-day those great capital expenditures are no longer possible, not because you cannot provide the capital, if you wished to do so, but because the outlets for your capital have been so largely exhausted. You may, and I hope you will, expend very large sums of money in rebuilding your small houses. But will that create work and provide income and buying power in anything like the same measure as your great capital expenditures did in the past ? Your government spent, in 1936, four thousand million dollars, borrowed money. There must be a great expansion of private credit if this expenditure is to be made good in the coming years for these great governmental credit expenditures are to be replaced by taxation. The taxes—not credit—the coming year are to provide the money needed to meet the government's expenditures. In so far as private credit takes the place of government credit, the prosperity of America will be maintained.

But it is doubtful if private credit can take the place of government credit to the amount necessary for to-day you are a developed nation with powers of production greatly in excess of its powers of consumption and needing to sell abroad a large part of your productions. Of course you should consume all you can of what you can produce, but you will still have a vast surplus that you must sell abroad. You cannot possibly consume all of the cotton you produce, you cannot possibly consume all of the wheat you produce if your harvest is normal, you cannot consume all of the minerals you can produce ; you cannot possibly use the vast quantity of motor-cars your factories can put out to-day. You must have a great world market. Your prosperity, therefore, now depends upon the world's prosperity as never before and if the world is in poverty America will be in distress.

And with this dependence of all nations upon world prosperity, we have a situation in which the world is moving along the road that leads to increasing poverty. The nations, after pursuing a policy of increasing interdependence for over a century, are now endeavoring again to become self contained. And the consequence must be inevitable disaster unless the policy can be changed.

I wish to express my appreciation, in the strongest possible manner, of the good work of your President and of Mr. Cordell Hull in trying to get your nation and other nations to understand that the policy of self-sufficiency is a grave mistake, that tariffs must be reduced—not increased—and hindrances to trade removed. I think they are performing a magnificent service.

But what is the response ? Are your own people likely to respond in the way the situation calls for ? Are the peoples of other nations likely to respond ? It is highly doubtful.

If I had been sure they would respond, I should not have come over here to speak of the danger which confronts the nations, I should not have gone to Europe, I should not be speaking in my own country in the way I am speaking. It is because of my doubt, because of my anxiety, that I am compelled to do what I can to induce people to understand so that the disaster which threatens the world may be averted.

You may say to me, " We have never heard anything like this before," Are there any great authorities who agree with you in this matter ? " " How is it that we have not been warned of this great danger ? "

I do want to say to you, and I say it not because I wish to blame anybody but because it is true. The peoples of all nations were warned, but they took no heed.

An agenda was prepared for the last World Economic Conference by the chief experts of all the great nations, including your own great experts representing the American Government. The British Government was represented by its official advisers. Those great experts stated definitely the cause of the world's troubles, the difficulties which the nations had in balancing their budgets, the vast amount of unemployment, the enormous reduction in the value of foreign trade, was due to the world's policy of self-sufficiency. Moreover, they said that unless the nations adopted a new policy by which the obstacles to trade were removed and this national self-sufficiency policy was abandoned, that certain consequences would inevitably be experienced. Furthermore they stated with a clarity that could not be misunderstood that if the nations continued their policies of national self-sufficiency and the Conference did not provide the remedy, the international financial system would be shaken to its foundations, the standard of life would

be so greatly reduced that the present social order could not be maintained.

Those of us who know what a great part the international financial system plays in the daily life of us all realized what this forecast meant. How far down will living standards go? What changes will come in the social order and what will be the suffering involved?

Alas, unless a complete change of front can be bought that prophecy of the experts is likely to be realized. I am not accusing any particular country. Your own government is trying to break down those trade barriers. Mr. Cordell Hull is doing all that he knows to set the world on to the road that leads to prosperity.

Nevertheless, world trade is being extended hardly at all. There has been recovery in the value of world trade in the past year, but it is due mainly to the rise in prices of food and raw materials, due to the world's restrictive policy. And the rest of the increase is mainly due to the increase in armament expenditures.

Now, you will say to me, "You have painted this picture of the world as it is, is there not another side?"

Yes, if you can induce statesmen and people throughout the world to understand and come together to consider these problems as world problems, problems that every nation must help to solve, and if we can induce the governments to meet together in a spirit of helpfulness, the problems can be solved.

But each nation must bring its contribution to the solution of the problems. In so far as nations are suffering injustice they must get redress, but the general idea of the Conference must be that every nation must play its part in preserving the world from the danger that is threatened and in placing it on the road which leads to increasing prosperity. Every nation must bring the contribution that it is, itself, capable of bringing.

May I say here that I believe the greatest contribution to the salvation of the nations through the solution of these problems can be made by the two great creditor nations, Great Britain and the United States. Between us we have the power to grant capital and credit, we have the power to give markets, and we have the power to introduce a new order into the world, the order of justice between nations.

The old order is gone. No, no; it has not gone yet. The distress of the world will continue until it is gone, but the peoples will not stand what they will be compelled to stand under existing conditions. The only possible way out of our difficulties is that the nations in the future must be just to each other. Yes, even generous.

No, no one will be hurt by showing generosity for it is that nation that will bring the most valuable contribution to the recovery of the world that will get the greatest advantage from it. You cannot make a contribution to the well-being of the world without deriving advantages. And it is that nation that will bring the biggest contribution, the most generous contribution, that will come out with the greatest prosperity.

If you will pardon me for saying so, Great Britain made the most valuable contribution of any nation to the welfare of the world up to the war. It provided a great free market to every country in the world. It provided the world with credit and with capital and it helped to develop the world as it was never before developed. And, as a result, British income and British trade expanded in far greater measure than that of any other country in a similar position.

That must be so. Bear in mind if you restore the well-being of other nations what you are doing; you are restoring the well-being of your own customers.

How can you hope to be prosperous if your customers are in distress?

May I point out that the great bankers in the world in the plea they issued a few years ago, begging the nations to be reasonable, expressed a truth that no one can controvert. They pointed out to the nations that "your neighbors are your customers, and their welfare is essential to your own well-being."

I was delighted the other day with President Roosevelt's speech in which he pointed out the necessity of promoting the welfare of the great mass of the people of this country. It must be done. It must be done in some way. By so doing you make good customers, you increase your turnover, you develop your trade.

Apply that to the world—two thousand millions of people in the world waiting to buy. Ah, and waiting to sell, waiting to produce the things in the quantities that everyone needs.

And the result? The result is not a dream, it is a reality. We have had experience. We know. I myself have witnessed it. I have seen the opening up of countries to trade and the well-being that came to the entire world in consequence.

Think of the benefits that you, the American people, conferred on the world when you developed this wonderful country in the way you did. You were not only contributing to the welfare of America, you were contributing to the welfare of all nations.

The world's income a hundred years before the war was just about twenty-five billions of dollars. Of course, the population, especially of western Europe and of America, then was comparatively small. That income grew in a single century five fold, from twenty-five billion dollars to one hundred and twenty-five billions of dollars.

Why? Why was it? It had taken all of the centuries for the world's income to come up to twenty-five billions of dollars and in one century it jumped from twenty-five billions to one hundred and twenty-five billions of dollars. It was because the world was developed and made interdependent.

In that time the nations had built 800,000 miles of railways. You here in America built 250,000 miles of railways. These railways made trade possible; it made production possible. Then great steamers were built to carry the produce across the oceans from country to country and continent to continent.

And the result of that was that international trade grew from under twenty-five hundred million dollars to twenty-five thousand million dollars.

You may say yes, but national income increase was in a much greater measure—not in percentage but in reality—than the growth of international trade.

May I point out to you a fact that is very important? In most countries people are apt to say: "Our foreign trade is only so much. Our national trade is so much. Therefore, our foreign trade represents only a very small percentage of our national trade."

That is a fallacy. When that income from foreign trade enters the various countries it circulates around those countries, and for every dollar of international trade at least two dollars of national trade are created as a result of the one dollar of international trade. It was because of that great growth of international trade that the world's income from both national and international trade grew in the manner it did.

When you sell your cotton to the world the money received goes circulating around the cotton States and from the cotton States to the manufacturers and back again, creating a great amount of trade and of income.

And so it is on the other side. When someone sells you something, the money proceeds goes back into that country and circulates around that country, creating an immense amount of national income and national trade.

And it is because that income from international trade is so sadly lacking to-day that you have this appalling shrinkage in national incomes.

The world to-day is engaged in economic war. If it is not brought to an end without delay it is likely to lead to revolutions, wars and world chaos and distress so great that one's mind refuses even to contemplate it.

That situation must be prevented. We must act as reasonable beings, realizing that the suffering that is threatened is quite unnecessary, and can be prevented. We can all come out into perfectly amazing prosperity if we act wisely.

What must be the keynote? The keynote of the future must be: How can each nation contribute to the well-being of all nations?

As soon as you look at it from that viewpoint, you see the consequences. Here to-day you have two thousand millions of people asking for a higher standard of living. The cry is coming from all countries. It is coming from your country too. Your poor people are no longer willing to go on living under the conditions under which they have been living. The cry is coming from the ends of the earth, "We want a higher standard of life."

Let us assist in producing the wealth that is contained in this amazing world of ours. Let us freely exchange the natural wealth which each country can produce for the natural wealth of other countries. And let us provide the capital and credit which is necessary to enable nations to develop their natural wealth.

You say, "Well, we have had the experience we had up to 1929, and we are rather doubtful." May I say that we, in Great Britain, have had a much longer experience and on the whole, our experience shows this policy means good business.

Supposing the American and British people to-day were to say to China, "We will provide you with the capital which will enable you to build that great railway system that you require, the great railway system that Sun Yat-sen planned." You know what the need of China is. China is in urgent need of that great railway system.

And what will it do? The building of those railways would enormously increase the productive power, the buying power, and the wealth of China. No single factor is more effective in raising the standard of life in any nation than good communications.

You have a nation like China with only 11,000 miles of railway, four millions of square miles of country, four hundred fifty millions of people. And you here in America, as I have said, have 250,000 miles of railway.

But why should we build railways for China? Because their construction would provide work for all kinds of people in a great many countries and would put money in circulation all over the world.

In giving this instance, I want you to understand the principle. Let us do the various things which contribute to the welfare of the world. In making that contribution we shall contribute to our own welfare. But we shall do more. We shall create a new spirit in the world, a spirit of co-operation, a spirit of assistance, a spirit of friendship.

You see in England we regard you as friends. I have always regarded America as a friend. And you, I am sure, regard Great Britain as a friend. Let us regard the other nations as friends too. Let us act toward them as friends. Let us try to help them to the utmost of our power, being as generous as it is possible to be—an attitude entirely different from the attitude of the world to-day.

What are you going to do? What are we going to do? Each one of us is trying to save himself at the expense of others. That is entirely wrong. It runs against economic law, but it also runs against Divine Law.

Yes. The Master gave expression to that Divine Law—"He that would save his life shall lose it. He that would give his life for my sake (in the cause of right doing) shall save it."

It is true, economically true, politically true, true from all points of view. The world is losing its life because of fear. Fear is everywhere dominating the nations. Throw it out. Take on a new spirit, the spirit of courage and understanding. Act rightly and wisely in the interest of mankind.

There is no need for revolution under such conditions. There is no need for war under those conditions. The nations will be able to obtain all that they are reasonably entitled to—a new spirit of understanding. How great will be the prosperity, I cannot measure, but so great that it is likely to exceed the expectations of the most sanguine.

The physical side of the world is set for the greatest trade expansion the world has ever seen. Never was there so much gold waiting to be used. Never were there so many machines, never were the desires of the people so great to produce, to sell, and to consume.

The world is capable of producing wealth, food, raw materials, and manufactured goods on a scale greater than ever before. It is physically possible to-day to provide the peoples of the entire world with all that they need.

Can you and I help bring about that state of public opinion that will enable these dreams to come true and these possibilities to be realized, to change the world from a world of enemy nations, each thinking of itself, its own interests and its own interests alone, into a world of friendly co-operating nations, bringing permanent peace and great prosperity?

The Far East and the Investor

On business investments alone the British stake in China is greater than that of any other country—or was as recently as 1931, when C. F. Remer made his study of foreign investments in China. Says *The Investors Chronicle.* Our stake, this journal continues, valued at U.S.$963,400,000, was approached by Japan's U.S.$912,800,000; but no other country came near to our figure. The U.S.A.'s share was only $155,-100,000. Those figures exclude Government obligations, on which also we are the leaders, with a total of $225,800,000. Our total investment, therefore, may be estimated to exceed £200,000,000, apart from indirect interests, such as steamship lines and cable companies serving the China trade. The sum is large. Yet its size must not be exaggerated if proper perspective is to be retained. The total is, for example, just about half of the combined nominal value of the L.M.S. Railway's share and debenture capital, and does not so greatly exceed the market valuation of Imperial Chemical Industries' shares.

The distribution of the business part of our investments over various business activities has been estimated as follows:—

	£'s millions	% of total
(1) Transportation	27.7	14
(2) Public utilities	9.9	5
(3) Mining	4.0	2
(4) Manufacturing	35.6	18
(5) Banking and finance	23.7	12
(6) Real estate	41.6	21
(7) Import and export and general trading	49.5	25
(8) Miscellaneous	5.9	3
	197.9	100

Of these sums, the investor in London can account for only a relatively small part. In transportation, shipping is the principal element. But the largest firms are not directly owned by the London investing public; and Indo-China Steam Navigation, which is well known here, is only partially interested in the Chinese trade. Public utilities are represented by Shanghai Waterworks, Shanghai Electric Construction, Hongkong and China Gas; and Oriental Telephone and Electric has a Chinese interest. But several of the larger companies are owned in Shanghai or Hongkong and never appear here. Mining is well represented by the Pekin Syndicate and the Chinese Engineering and Mining Co., but in any case only represents a small proportion of the total. In the really large interests (i.e., general trading, real estate and manufacturing), the London public has practically no direct interest at all—though through the well-spread interests of the British American Tobacco Co. there is a considerable indirect stake, and such businesses as Whiteway Laidlaw have part of their retailing interests in China. And finally, while the great Hongkong and Shanghai Banking Corporation is well known to English investors, its business is far from accounting for the whole of the banking and financial investment.

The direct public interests, therefore, are relatively small. And even when indirect interests begin to be reckoned the field widens only moderately. Manifestly, the shipping and cable business must be included. That means P. & O. and Cable and Wireless. But it may be observed that while the P. & O. will only be hit in a section of its trade where subsidized competition is already fierce, Cable and Wireless suffers on a route important not only for its total business, but also relatively secure from the insidious competition of air mail, owing to the very great distances involved. Nor is the direct repercussion on our foreign trade so very serious a matter, since we may consider ourselves fortunate, for once, that the stake has already been greatly reduced. In 1913 our exports to China were £14.8 millions; last year they were about £6 millions. Despite a growth in our imports from China, the total turnover is only about one per cent of our total foreign trade; and even if the Hongkong trade be added the increase is unimportant in relation to our total overseas business. As for Lancashire's stake in the Chinese market, it is much less than generally supposed. Last year the combined exports of piece goods to Hongkong and China together only slightly exceeded in value our sales to such countries as Cuba and Peru; and in yarns the total was about

one tenth of the purchases of our best customer, Germany. Even if the stake in the Japan trade is added in, the proportions remain very modest.

There is, however, another possibility to be reckoned with: that as a reaction of disgust at Japanese measures, an unofficial, or even an official, embargo may sooner or later by put on Japanese trade. It is being pointed out with growing stress both in America and here, that if the British Empire and America, together, were to ban import and export trade with Japan, the Japanese economy would be undermined. At present such an embargo does not seem an immediate likelihood; but the embargo is there, a potent weapon for use if we are greatly provoked, and the investor has always to reckon with possibilities. Out of total Japanese imports of 2,472 million yen in 1935, no less than 810 million came from the U.S.A., 306 million from British India and 235 million from Australia. To stop up those sources of supply would deprive Japan of her vital raw cotton and wool. If the same groups were to close their ports to Japanese exports, a market of 535 million yen would be lost in the U.S.A. (out of total Japanese exports of 2,499 million in 1935), 276 million lost in British India and 119 million in Great Britain, while the great China trade of Japan is already lost.

If, therefore, Japan's trade were to be crippled, important results would follow. Whether in the increased political tension which would result investors would harvest much profit in share values, might be uncertain. But it is clear that the absence of Japan would open wide vistas to Lancashire in the cotton trade, and, to judge from Mr. Courtauld's speeches, would not be unwelcome to the rayon industry. Not only would Japanese rayon exports dry up, but the silk business of the world, cut off from its supply of Japanese (and probably of Chinese) raw silk, would yield a still further share in its market to rayon. Momentarily, the struggles of Japan may have an opposite effect, as her stocks of rayon yarn and raw materials are believed to be large, and she may not hesitate to throw her products on the market while she can, to raise foreign exchange. But on a short-term movement of that kind it would be direct competitors who would be hardest hit; and Japan's most important direct competitor in cheap rayon is her old friend Italy.

The general conclusion seems to be that the commercial possibilities of Japan's aggression are not seriously dangerous to this country, and even less so to the public investor. It is even possible that a gain might accrue to us in certain circumstances—provided that the war risk did not grow so greatly in the process as to nullify gains elsewhere. Meanwhile, such investments as we have with direct and proximate interest in the China, Japan or other Far Eastern trade are manifestly likely to suffer. But fortunately they are smaller than is generally supposed.

Trade Surmounting Wartime Handicaps

No export market offers greater possibilities for the future than China, according to a report drawn up before the outbreak of hostilities by the Special China Committee of the Federation of British Industries, says *The Yorkshire Post*.

The report shows the potentialities of the Chinese market before the present hostilities arose, and also the considerable attention already given by British Industrial interests to the question of securing a satisfactory proportion of the contracts involved in the expected development of China.

The report states that the appointment of the Committee, in 1936, was due to the realization of two factors. The first was the increasing stability of the Chinese National Government, resulting in ambitious plans for economic development, and the second was the increasing competition from Germany and Japan in capital goods, due in the former case to the operation of the German export subsidy and ability to export as a national unit, and on the latter to Japan's low labor costs, more favorable exchange and proximity to China.

Capital Goods

The Committee realized at the outset that the United Kingdom's greatest hope for future trade in China lay in the supply of capital goods for the purposes mentioned. It was considered that a useful step would be for British manufacturers to co-operate in eliminating internal competition and in helping to overcome foreign competition by some system of pooling of overseas inquiries within industries and of concentrating on selected tenders.

Medium or long-term credits are an indispensable condition of obtaining important contracts in China, and it was considered essential that the United Kingdom should make greater use of her credit resources in that country. It was felt that the Exports Credits Guarantee Department could be of very material assistance to British industry in securing such contracts, and special consideration was therefore given to the Department's scheme as already operating and the manner in which it could best be adapted to meet the special requirements of the China market.

The Committee, while agreeing that the method of representation must be determined by the circumstances of particular cases, felt that in specialized engineering lines the maintenance in China of a technical expert by the manufacturer was essential to the successful exploitation of the market.

German Salesmanship

Where individual manufacturers could not afford the cost, it was suggested that competing manufacturers, or possibly the whole industry should arrange to share the expense of a technical expert and pool inquiries.

It was felt that the need for closer contacts with prospective purchasers called for the selection of personnel capable of mixing on the friendliest possible terms with Chinese buyers. Germany's success in getting business in China was due not merely to her ability to quote low prices and offer long credits, but largely to the energy and thoroughness with which her salesmen established contacts, worked out proposals and followed them up.

Generally speaking, the Committee's view was that the economic development of China might be delayed, but would not be arrested by the present hostilities. They therefore considered it highly important that British manufacturers should maintain their organizations and interests in China, even at a time when disturbed conditions might make it seem unprofitable, as of all export markets none offered greater possibilities for the future than China.

Trade with China

Supplementing the foregoing *The Electrical Times* discusses another report dealing with trade in China presented some time before hostilities opened by Sir Louis Beale, British Commercial Counsellor at Shanghai. This is as follows:

In view of the present disturbed state of affairs in China the report of Sir Louis Beale (Commercial Counsellor at Shanghai) on the economic and commercial conditions in that country, just issued by the Department of Overseas Trade, will be read with special interest. The report was written before the outbreak of the military and naval operations now proceeding and the period discussed marked the change from depression to a revival of prosperity. It is noted that the mass of the people are solidly behind the national Government, and attention is drawn to its policy of unification. Stress is laid on the increasing confidence which the Chinese themselves and the world at large have in the future of the country and it is pointed out that the traditional friendship of China and Great Britain is a vital and living force which is being applied with steadily increasing success in many areas of China's economic field, but the magnitude of China's needs in her economic development—communications, industries, and technical skill—provide an opportunity for the United Kingdom to contribute to the building up of modern China on sound foundations, a task of the greatest importance and value to China and to the rest of the world. It is for Great Britain to grasp the opportunity of assisting China in the fields of planning and creating her public utilities, communications and basic industries.

The hostilities now proceeding must, of necessity, be a handicap to the country, but China in any case would seem to offer rich

possibilities for British trade. Whilst it is stated that our channels of trade and finance in China are efficient and reasonably adequate, Great Britain lags behind some of her competitors in the provision of technical men. The major orders secured by United Kingdom firms in the equipment field in recent years have been in practically every case the work of an expert on the spot, but largely because our experts were too few we secured in 1936 no more than 16 per cent of the total trade in the iron, steel, machinery and allied group. "Suppliers," says the report, "successfully establishing themselves now in this market, even though, because of keen competition, profits are cut very fine, are laying the foundations of a share of a trade in the future, the immensity of which cannot be estimated. German heavy electrical equipment, American motor-cars and aeroplanes, are examples of non-British exports which are likely not only to become standard in the Chinese market, but to increase substantially in volume and value."

The total value of the trade of China with the British Empire in 1936 was $429,452,000. Separate figures with regard to the imports of electrical machinery and equipment are not given, but under the heading of "machinery," boilers and boiling-room equipment is put at $5,000,000; turbo generators, sets and parts, $3,000,000; and electric motors and parts at $2,000,000. The United Kingdom secured 50 per cent of the trade for boilers and boiler equipment, due largely to the efficient organization in China of a leading British firm. Our share of the trade for turbo generators and parts was only 11 per cent as compared with the 51 per cent of Germany and 24 per cent of Switzerland.

Under the heading of "Miscellaneous Metal Manufactures" are included electric cables, $1,500,000; insulated wire $2,500,000; electrical fittings, meters and lamps, telephones and telegraphic instruments, $2,500,000; and radio sets and parts, $4,000,000. The United Kingdom secured 17 per cent of the whole group as compared with 29 per cent by Germany and 37 per cent by the United States. The figures quoted are Chinese dollars.

Dealing with the home industry it is reported that the manufacture of electrical goods and appliances (undertaken to cope with the country's growing demand for such goods following the popularization of electricity) is one of the most successful of new industrial ventures in China. One of the most important branches of this industry is the manufacture of electric bulbs. The first Chinese factory was put up in 1925, but at present there are in all 15 factories, in addition to a large American factory. Three of the Chinese factories were established in 1936. The annual production of Chinese factories is estimated at 15,000,000 bulbs, and with another 5,000,000 estimated to be produced by the foreign factory, this meets the bulk of China's present requirements. Of the raw materials used in this industry, however, only the glass and lead are procured locally, while most of the metal requirements are imported. Attention has, therefore, been called to the fact that as China is the chief tungsten producing country, steps should be taken for a plant to be set up for the manufacture of filament wire to supply this industry. Electric fans, motors, and in fact, almost the complete range of electrical appliances are well and successfully made in China, to the growing exclusion of the imported product.

Some Aspects of the Rehabilitation of China's Railways

By KENNETH CANTLIE

(Following is the text of a lecture given by Mr. Cantlie, who is well known as Technical Adviser to the Chinese Ministry of Railways, before the China Society on May 7, 1937)

In order to give a clear conception of the state of the railways, it seems essential to give a short historical survey in order to demonstrate how the railways came to be in the lamentable state that they were in 1931.

China's first railway, if we agree to exclude the short-lived Shanghai-Woosung Railway, was built by a mining concern and later worked as a private railway company. It was found, however, that the difficulty of raising private Chinese capital made it desirable for the Chinese Imperial Government to intervene in order to complete an extension of the line to the capital (Peking). As Chinese capitalists were still reluctant to invest in railways, even under the Government ægis, the Chinese Government obtained a foreign loan by an issue of bonds through the Hongkong and Shanghai Bank under certain stipulations by the bank which took the form of a "Loan Agreement." These conditions stipulated that, through the appointment of Britons to key posts on the railway, a large measure of financial and administrative control should be in their hands. The arrangement might be considered a modification of the system of foreign railway companies such as was, and is, successfully operated in South America and other countries, and was created to meet the natural desire of the Chinese to have at least nominal control of the only modern means of communication in the Empire.

The refusal to entertain the idea of foreign-controlled private railway companies under strict Government inspection was also caused by the system of legal extra-territoriality then and now in force under which the subjects of important nations were under Consular, and not Chinese, jurisdiction. This system, which was a modification of that adopted in the Turkish Empire in the sixteenth century, though excellent in theory, has not, for various reasons, had good results in China, and in practice has sometimes hampered progress, as in the present case.

The original loan agreement concluded between the Chinese Government and the Hongkong and Shanghai Bank, as the agents for foreign bondholders, was regarded as a model, and was imitated to a greater or less extent by later loan agreements.

The ensuing period in China's history was an unsavoury one. China had been so greatly weakened by the Sino-Japanese War that it seemed to the world that the break-up of the Empire was at hand, and each great Power manœuvred to prevent any other Powers from seizing part or all of it. These manœuvres often took the form of forestalling other nations in their attempts to secure railway and other concessions and also of enhancing as much as possible their trade with China. In consequence there followed what has been called the "Battle of Concessions." In so far as railways are concerned, the Powers saw that railway concessions were not only politically desirable, but economically profitable; competition in this sphere was keen, and several of China's major railways came into existence as a result.

The Boxer Rising called a halt to these politico-economic manœuvres, and after the Russo-Japanese War the enhanced comparative strength of Britain and the United States in China causing a relaxation of the expectation that China was shortly to be divided up by the Powers, the clamor for political railway concessions died. Thereafter loans for railway construction were made upon a business basis, though as the lenders were still supported by their Governments this often resulted in political pressure being put upon the Chinese Government. Many Chinese as a consequence not unnaturally failed to note the fundamental difference in the basis of the loans, and could see little improvement in China's position.

In justice to all parties it might be pointed out that, though political pressure was frequently used to procure further advantages for foreign syndicates, it was also much used to overcome obscurantism, petty restrictions, and favoritism on the part of some of the officials. Nevertheless, though the results may often have been good, pressure of this kind could not fail to cause resentment in such a justifiably proud nation as the Chinese.

The scrupulous care with which payment was made on the railway bonds as they fell due improved China's credit rapidly, and the terms on which railway bonds could be sold on foreign markets became progressively easier. As a result, loan agreement safeguarding clauses (employment of foreign staff, deposition of funds, etc.) became less and less stringent.

In 1911 the Chinese Imperial Government decided to take back direct control of the trunk railways from the Provincial Governments, and this was the immediate cause of the Revolution which

caused the displacement of the Manchu dynasty. The effect of the Revolution on the railways was not great, and after a short pause the flow of foreign money and materials to China for railway construction was actually accelerated.

The Great War, however, caused an absolute cessation of foreign lending, and its aftermath of financial confusion prevented any renewal of interest in Chinese railways. In the meantime China had commenced that long period of civil wars which, reminiscent as they were of England's Wars of the Roses, were extremely confusing to outsiders, and caused conservative foreign financial interests to await tranquillity before re-entering the investment field.

Railways, being the sole modern means of transport, naturally suffered severely during this period, and the foreign railway officers, whose dual duties under the Loan Agreements were to safeguard not only the rights of the Central Government, but also the interests of the foreign bondholders, were placed in an invidious position, and had to endeavor to withstand the requirements of the various War Lords and Governors in whose territories they chanced to be. In consequence, a large majority of the foreign staff, and also many of the experienced Chinese staff, on the various railways were removed and their substitutes were frequently military or political appointees whose knowledge of railway matters was sometimes small.

The rise of the Nationalists in 1926 was followed by their split with the Communists in 1927. Prior to the split much communist propaganda had been spread, and this had caused a large fall in the efficiency of the various railways, especially in shops and sheds, due to decay of discipline. It became, consequently, less and less possible to repair the damage to the railways done in the civil wars.

To the heavy damage to rolling-stock resulting from the wars there was added the wholesale removal of locomotives, carriages, and wagons by the "Old Marshal" Chang Tso-lin when he retreated to "the three Eastern Provinces" (as the Chinese call Manchuria), and this equipment was used by him on the new railways which he built in Manchuria, and little of this stock ever returned to the owning railways (mainly the Peiping-Hankow, Tientsin-Pukow, Peiping-Suiyuan, and Lunghai).

In 1929 the National Government occupied Peking (the name of which was changed from "Peking," Northern Capital, to "Peiping," Northern Peace), and there came a period of peace. A Ministry of Railways was then established (formerly the railways had been under the Ministry of Communications) in Nanking, the new national capital, to endeavor to rehabilitate the railways, which by then were in a deplorable condition. On some lines as many as 60 per cent of the locomotives were out of service, and the condition of rolling-stock was almost as bad. Interest on bonds was in arrears on almost all lines, and repayment of, or even interest payments on, the large material loans, which during the wars had been made on increasingly onerous terms, was also impossible.

Before palliatives were possible, yet another war broke out, led by certain discontented leaders then in the north. For six months the struggle continued along the Peiping-Hankow, Tientsin-Pukow, and the Lunghai lines, and still more damage was done.

The ensuing peace found the majority of the railways in a condition little short of chaotic, with but a small proportion of serviceable rolling-stock, over-aged and rotten sleepers, patched and weakened bridges, a shortage of spares of all kinds, an insubordinate staff heavily in arrears with salaries and wages, and an enormous mass of both long-term and short-term indebtedness which increased inexorably year by year, much of it at heavy compound interest.

That was the problem confronting the Ministry of Railways in 1931.

Conditions in 1931

It is no exaggeration to say that the task facing the Ministry of Railways in 1931 was one of the most complex and difficult railway problems which has ever been faced.

The railways were in ruins, large expenditure was necessary to keep them at work at all, and yet money could only be borrowed on almost prohibitive terms which still further increased the load of debt, already so great that the ability of the railways to pay it off at all was already questioned. Any railway official might be forgiven, therefore, who regarded the task as impossible.

The form of capitalization of the railways was a handicap, as, being a bond, and not a share, indebtedness, it was inflexible, and allowed no margin for the bad times which the railways were now experiencing. Fortunately the bondholders, to their credit, realized the difficulties, and did not adopt an intransigent attitude, which would still further have complicated the position. The foundation of the subsequent improvement in the railways was, therefore, the desire of the Government and Ministry of Railways to honor its indebtedness and the willingness of the bondholders to take a broad view of the situation. The fact that tacit co-operation existed between them almost from the beginning should never be forgotten.

The Chinese people have, throughout the centuries, suffered at frequent intervals from famine, pestilence, floods, and other natural and national disasters. This has developed within them a stoical outlook and philosophy which is the admiration of other nations. This stoicism was well exemplified by the attitude of the general public towards the Chinese railways at this period. Trains were few, crowded, slow, and grossly unpunctual. The carriages were dirty and damaged, failures were frequent, and the unpaid railway staff frequently obtained money by illegal charges. All these troubles were faced by railway users with a cheerful equanimity which would be met with in no other country.

The movement of freight which had been awaiting the restoration of train services was considerable, and called for the utilization of every serviceable wagon. Revenues, therefore, soon reached substantial figures. The railways, however, were in far too serious a condition for this revenue to have any immediate effect on their general position. Their credit was strained to the utmost to provide the wherewithal to continue operation, while the result of years of neglect may be seen in the enormously enhanced Operating Ratios. Furthermore, unproductive transport and taxation were still at a high level.

It should be remembered that it is the average of the railways which is being considered. Some railways in the coastal areas were in much better condition than those inland for several reasons. The Loan Agreements of these railways prevented them from giving much assistance to less fortunate lines.

At the outset, therefore, there was little opportunity for creating a detailed program of rehabilitation, such as the Russian Five-year Plan. The Ministry and the railways found that the only possible course was to use the available revenues to pay off the most urgent creditors, and thus secure sufficient new credit to continue operation. To do this coal, oil, consumable stores, and a few vital spares were essential, and equally urgent was the purchase of new sleepers. The renewal programs were all in serious arrears, and on some lines the state of the track was so weak that it was dangerous to run at any greater speed than twenty miles per hour and sometimes even less. At least two million sleepers were required as soon as possible.

In September of 1931 occurred the Mukden incident which led immediately to the occupation of Manchuria. I have particularly keen recollections of this, as I was sent by the Ministry to discover and report on what the position actually was. The occupation of Manchuria and the subsequent creation of a new State in that area reduced the lines under the ægis of the Ministry of Railways by about 3,500 kilos, and at the same time rendered permanent the loss of the locomotives and rolling-stock taken away by Chang Tso-lin.

In January, 1932, occurred the Shanghai affair, which caused an estimated damage of $30,000,000 to the Nanking-Shanghai railway, including a serious loss of revenues due to complete cessation for three months and a restricted service for several months afterwards and the partial destruction of the shops and stores. Not only the Nanking-Shanghai, but also the connecting-lines suffered through loss of traffic. I may add here a personal note, as I spent considerable time at the temporary headquarters of the line at Changchow, and say that some of the feats of transportation performed in supplying the 19th Route Army were of a very high grade considering that the line was single.

These events naturally caused a sharp drop in revenue, and it was not until 1935 that the revenue rose above the 1931 level. Despite this setback, however, the reorganization of the other lines was proceeding. It must not, however, be assumed that this reorganization could be effected in an atmosphere of calm consideration. Interruptions and emergencies continued throughout, while varying subsidies to military expenses and local contributions caused financial uncertainty.

Efforts were made to create a long-term system or a plan to improve the railways, but this had to be varied with changing

circumstances. Furthermore, the reduction of Operating Expenses by an increase in the efficiency and a decrease in the number of the staff, as would be done in an industrial undertaking, could be carried through only to a very minor extent owing to political reasons. These reasons are simple : in a democracy political power is often dependent on popularity. A high official who created unemployment by reducing staff would not be likely to increase his popularity, to say the least, and there was, therefore, an inevitable tendency to retain surplus staff until they could be given posts on the new railways which, everyone anticipated, would shortly be built.

Revenues continued to mount. Payment was made of wages and salaries, and a start made on annulling the arrears of back pay, thus causing more content among the staff. Sums became available not only for sleepers, but for the purchase of fire-box steel, tyres, drills, tool-steel, and other necessary items, and also some spares in quantities sufficient to permit the shops to cease robbing unserviceable locomotives and rolling-stock of spare parts in order to keep the remainder in repair.

The workshops of the railways were choked with unserviceable and wrecked locomotives and rolling-stock. Many of these would have been uneconomic to repair had new capital been cheaper, but as it was repairs had to be done as opportunity offered. The general shortage of locomotives and rolling-stock was limiting the earnings of the railways very considerably, and in addition many wagons were under military control ; the turn-round of the wagons was often tardy ; and the engines were, on the average, unable to pull more than about 50 to 60 per cent of what they should. A vicious circle had been formed. Shortage of rolling-stock and higher Operating Expenses were preventing payment of external debts, and until these were paid capital could not be borrowed to buy new rolling-stock and/or reduce Operating Expenses.

It may, of course, be argued that the Government as a whole might have come to the assistance of the Ministry of Railways, but this had not hitherto been the custom, and, though the Ministry had large claims against other Government departments for military transport, etc., those departments had large counter-claims. The position was so complicated that some time may still elapse before all details are finally adjusted. The only method at that time possible for the Ministry of Railways was, consequently, to proceed independently, and, while endeavoring to sustain the credit of the lines whose bonds had not sunk to hopelessly low values, to devote as much revenue as possible to material improvements in the railways, including the purchase of new locomotives and rolling-stock which, by increasing the speed and number of the trains running, would considerably augment the revenue.

The Locomotives and Rolling-stock

Repair of existing locomotives and rolling-stock had naturally become of prime importance, and as the growth of the shops had failed in past years to keep pace with the increase in locomotives and rolling-stock, the heavy damages of the war years had put them seriously in arrears. Furthermore, the changes in personnel and the spread of discontent among the staff during the disturbed years had lowered the efficiency and outturn of almost all the shops.

To overtake the arrears some shops worked as many as four hours of overtime per day, while others adopted the two-shift system. Neither of these schemes was wholly successful in its object, as shortage of spare parts, stores, and extra skilled staff prevented the outturn from increasing in proportion to the extra hours worked.

Typical of the small but vital difficulties besetting the mechanical officials was the impossibility of transferring staff from sheds and depôts to shops, as the staff, being in arrears with their salaries, were owing such large sums to local tradesmen as to make transfer impossible. Furthermore, the shop staff objected to sending " their " engines for repair to the shops of other railways, as they feared reduction of staff as an ultimate consequence.

As the months passed the accumulation of locomotives and rolling-stock awaiting repairs at the various shops actually increased to a considerable extent, due to the resumption of heavy mileage entailing breakages of worn-out parts and for another important cause. This was the large number of tyres of minimum thickness extant, many of which became loose. They were kept running either by fastening the tyres to the wheel-spokes by cramps or by putting liners between them. In either case it was impossible to use the brake-blocks on these tyres, and these were removed. In consequence the braking power of engines and trains was seriously diminished and frequent collisions occurred as a result.

The condition of the shops had serious repercussions on the sheds. It became impossible for either shops or sheds to maintain stocks of finished parts, and to relieve the shops rough castings instead of finished parts were sent out to each shed which possessed suitable machine tools. The system, however, did not work out well, as not only was the skilled staff at the sheds of a very low quality, but as large numbers of castings could not be sent from shops it was usually impossible for the sheds to machine for stock, and engines had to be held up while parts were finished.

The foregoing difficulties were intensified by the fact that locomotives and rolling-stock of different lines, which had become mingled during the troubled periods, had not as yet been sorted out to any great extent, due to the competition of all the lines for the least damaged cars irrespective of ownership. Each railway feared exchanging a good vehicle for a bad one, and in consequence interchange of wagons entirely ceased for a period, and only recommenced after many wagons had been repainted in the using line's colors. Before the wagons were sorted out some years elapsed, and during this time, as may be imagined, the multiplicity of equipment on each railway was a serious handicap to the shops and sheds.

Locomotive boilers were, perhaps, the most difficult feature of this difficult period. A very large proportion of the boilers in China were, and are, over-age according to the usual computations, and fire-boxes were in extremely poor condition. As only the cheapest materials could be afforded for repairs, they gave constant trouble, which was accentuated by the fact that the shortage of good boiler-makers, and even more of competent boiler-inspectors, was, and always has been, acute. Careless washing-out of boilers frequently caused scorched plates through accumulations of scale, while unskilful repair work caused grooved tube-ends, cracked tube-plate bridges, and bulged tube-sheets. Inasmuch as spare boilers did not exist on many of the railways, the delays to engines waiting for boilers were, as can be imagined very great.

Welding here came to the rescue. Some good welders had been obtained on some of the lines, and some extraordinary feats of welding were attempted, often with some success. Tube holes in tube-plates had often been brought back to size by welding, and cracked tube-plate bridges repaired, but more ambitious repairs were now carried out, such as welding new flanges to tube-plates, or even welding two halves of a tube-plate together. Superheater flues had rings welded on, while superheater elements had had their return bends, elbows, and ball-joints welded to such a degree that the extent of the steam passage through them was a matter of doubt. On some engines the entire superheater had been short-circuited at the header owing to shortage of elements. Much welding of pitted sheets and foundation rings was done, though not always with success. Despite these efforts the condition of the boilers was, it will be easily understood, very bad indeed, and hydraulic tests revealed such multitudinous small leaks, which nothing but new materials would rectify, that steam pressures had to be reduced; sometimes very materially.

The purchase of spare boilers and fire-boxes, and also of good-quality sheeting and stay-bolt material, soon caused an improvement, though it will be long before the boiler position is what it should be. One of the main obstacles to rapid improvement was the lack of standard classes of boiler. In China the average number of boilers of each type is less than five, and the fittings and connections are almost as diverse. An attempt to provide standard boilers for several similar classes of existing engines is to be made, and with clever designing much may be done.

The state of the engines apart from the boilers was also the cause of grave anxiety. Loose tyres have been already mentioned and their corollary of collisions, but another result of the rough treatment the engines had undergone was that of cracked frames, which were a very common feature. Both bar and plate frames cracked, but whereas the former cracked generally as the ultimate result of a collision, cracks in the latter were usually the result of a derailment. Plate frames had formerly an advantage over bar frames in that in a collision they bent rather than broke, but the advent of welding had largely nullified this advantage, and as the number of plate frames which cracked due to wear and tear was

rather higher in China than elsewhere, there was little to choose in efficiency between the two types.

Cracked spokes were to be found in almost every engine, and welding was here of little permanent value. A large number of axles were of minimum diameter. Some of these had to be built up by welding, but in some cases leading and trailing coupled axles could be transposed without upsetting the balance of the wheels, and as the axle-wear took place mainly on the trailing axle, a new lease of life for it was thus provided at no cost. Bearing springs had been broken and replaced so often that the plates were latterly of very poor quality steel which required yet more frequent replacement, while cracked and loose buckles were an additional trouble.

The walls of cylinders had in many cases become dangerously thin, but only too frequently neither new cylinders nor new liners could be afforded. Where new and larger piston-heads to fit the worn cylinders were unobtainable, bronze or iron junk rings were cast on to the original heads.

Poor quality brass was a great handicap. On many of the lines the brass which was used for the best quality work had greatly declined in quality as a result of being repeatedly remelted and re-used. Crown brasses and side-rod brasses made of this brass wore out very rapidly, while boiler fittings soon leaked and required replacement.

In addition to these main causes a great many minor points caused extra trouble and work. One may be cited as an example. This was the worn-out and scorched condition of many smoke-box doors, which had ceased to be airtight, and thus impeded the steam-raising capabilities of the engines to which they were fitted. Replacement of these doors was essential, but could not be afforded, and instead fire-clay had to be used in large quantities to stop the leaks before the engines left the shed.

In the matter of carriages the condition was as bad as that of the locomotives and boilers. A large proportion of the up-to-date coaching stock, especially from the Peiping-Hankow line, had, as stated, been removed by Chang Tso-lin, and had never returned or been replaced further than by the conversion of wagons to lower-class passenger stock. Also the various campaigns had reduced all carriages to a common level of dirt, decay, and wreckage. Apart from the many cars which had been burned out or smashed in collision, all mechanical parts, such as tyres, couplers, brake-gear, and lighting, were badly worn, while the upholstery, etc., was in a very bad state.

Most of the bodies were of wood, and as Chinese people have a genius for working in this material, new bodies were built on the old frames, and if the design of these was sometimes imperfect the workmanship was adequate, though as softwood had to be used the life of the these bodies was short. Interior fittings were repaired as far as supplies permitted. As money becomes available these carriages will be steadily improved, and the provision of extra stock will permit of the reconversion of the wagons running temporarily as carriages.

In the matter of wagons much could be said. At the end of 1931 wrecked and disabled wagons were scattered all over the war-zone. Slowly they were moved to shops, and a certain amount of repair done by transferring sound parts. From that time onwards steady work has been done in repairing the remainder. Wagons have gone out containing little but the original sole-bars, and even these have been laboriously straightened and reshaped.

It should again be pointed out that the only justification for some of the repairs carried out was the high cost of capital. Had it been possible to borrow new capital on reasonable terms, the wagons referred to above would certainly have been scrapped, but with the then condition of the money market the interest and amortization rates on capital borrowed to purchase new wagons would have more than swallowed up the savings made by the reduction in repairs and maintenance. It is an excellent example of how completely railway repair policy is based on the cost, and the future estimated cost, of capital, and applies to all railway equipment.

The Permanent Way

In our survey of the railways at that period we can now turn to the permanent way. The main need, as already mentioned, was for new sleepers. Shortage and cost of capital again entered into the problem and made the higher cost of hardwood or creosoted softwood not only difficult to afford, but financially unprofitable, and softwood was accordingly used in the majority of cases, though it was known that its life could not exceed about eight years, and in some districts less than three. The cleanliness of the ballast had a considerable effect on the life of the sleepers, but, though the gangs were adequate, it was frequently impossible to clean the ballast unless complete sections were relaid with new sleepers throughout, as so rotten were the old sleepers that had the ballast been dug out for cleaning the sleepers would have fallen to pieces. Ballast cleaning was, therefore, in many cases impossible, and sleepers, both new and old, lay in damp mud and their life was but short.

As to the rails, these were, in almost all cases, the identical ones that were laid when the line was first built, and they had suffered badly during their long life. The running surface of the rail, instead of being a curve, was too often worn completely flat; the rail-ends were battered and frequently had a permanent set, having low joints and high centers, which refused to yield to treatment. Their fish-plates were in still worse case, for they were so worn that they could no longer span the web of the rail and hold the joint solid by wedging themselves between the head and foot.

The repair and renewal of sleepers and bridges was more urgent than renewal of rails, for, apart from the flat rail-top, it could not be maintained that the state of the rails was actually dangerous. But when funds became available, albeit in limited amounts, a start was made in shimmying the fish-plates and raising the rail-joint. By the use of a special joint-jack, such as is used in the Federated Malay States, it is hoped that the rails can be straightened in a vertical direction. Cropping the rail-ends in order to improve the joints has often been suggested, but this has the cardinal objection that it means buying a certain amount of new rail. For the larger 85-pound rail, which is standard on the majority of lines, it may prove possible, when the machinery exists, to re-roll these rails into 75-pound rails, and thus correct all their faults at one time, making them suitable for secondary lines.

The Bridges

During the wars many of the bridges had been destroyed, the broken spans jacked up and mounted on sleeper stacks, and frequently destroyed again. Many bent and damaged girders were removed and laboriously straightened and patched. Others had to be replaced. To provide material, bridges over water-courses normally dry were replaced by Irish bridges (that is to say, the tracks were laid across the bed of the water-course with stone dressing). In this way a number of extra spans were obtained which were used either whole or in parts. Old rails or timber bents were used to support, either temporarily or semi-permanently, spans which had been permanently weakened as a result of multiple damage. It need not be emphasized that had capital been cheaper a large proportion of this work would not have been undertaken, as it would have been better in every way, and more economical, to replace the broken spans with new and stronger bridges.

It had been noted that welding has been widely used in locomotive and rolling-stock repair, and it was natural that the use of welding for strengthening the older and weaker bridges should have been mooted. Despite some reports of failure due to inability to anneal the weld after completion, many welded bridges in other countries have given no trouble, and in the present case the attempt is well worth while and is being carried out.

China is unusual in that the rails have on most lines always been stronger than the bridges, and in consequence the limit to locomotive size is not axle-load, but its effect on a bridge of certain strength. Until now it has been usual to take a certain Cooper loading. This is an American loading very similar to the British Engineering Standards Association's standard loadings. In view of the weak bridges, it became necessary to investigate what was actually the maximum size of locomotive which could safely negotiate each bridge. It requires no investigation but merely common-sense to show that a locomotive, when travelling across a bridge at speed, will cause more strain to the bridge than if it is standing still upon that bridge, and the higher the speed the greater the disturbances set up in the bridge. Therefore to apply as a test a load which was stationary was clearly incorrect. This is, of course, generally agreed, and consequently a certain percentage is usually added to the bridge load, varying with each length of span, to allow for the greater strain to the bridge caused

by high speed. No two bridge experts, however, are agreed what is the correct allowance to make for each span, the allowance on a 200-foot span varying from five to 40 per cent approximately. It will be obvious that the whole system is rule-of-thumb and depends on a large safety factor. The Bridge Stress Committee, which were a Royal Commission, went into the whole matter far more thoroughly than it had ever been investigated previously, and stated as a result that in their opinion the whole procedure outlined in the foregoing was wrong, and that instead of adding a theoretical formula to a static load, the actual forces set up by each engine should be found. After many experiments they set out some standards which, though they apply more particularly to British engines, can be applied in principle to any engine in the world.

The percentage added to many bridges in China was proposed by Professor Turneure, and allows a considerable increase in strength for all spans. By working out the actual effect of engines on bridges on the lines suggested in the Bridge Stress Committee's report, and checking this against the actual gross strength of the bridge after making a deduction for vibration on the longs pans, the actual margin of strength of the bridge at all speeds can be found.

Naturally the effect on a bridge differs with each individual engine. The slower the speed, the smaller the effect. Also the larger the driving wheels, the smaller the effect. The latest types of engine for China, especially the large 4-8-4 design for the Canton-Hankow line, were designed with these points in mind, and, though they exceed the static weight-limit, have given no trouble on bridges.

The Other Departments

This survey of the various railway departments to obtain a bird's-eye view of what they were doing to overcome the difficulties of the position must include the Traffic Department. This was naturally put to great difficulties to maintain the traffic by the difficulties already mentioned, and also by the fact that with two minor exceptions all the main lines in China are single track. In consequence the crossing of trains without delay depends on the punctual arrival of both. If one train going north is late, the south-bound train which crosses it at a certain station will also be made late. Unless the latter train can make up lost time, it will delay all north-bound trains which it crosses, and so on. With engines in bad condition delays were frequent ; furthermore, with a strict speed limit to avoid danger on rotten sleepers it was impossible for trains, once late, to make up more than a trifling amount of time, even if the engine happened to be in good order. In consequence the time-keeping of trains was very poor, and on some lines became so bad that trains of the previous day delayed trains on the following day, and prevented any fresh start being made each morning. As the railways in China do not observe Sunday as a time of rest, and as exactly the same service is run, it thus became impossible to correct matters without a wholesale cancelling of trains or the conversion of certain regular trains to specials. The result of this late running was that it was impossible to roster engines or crews for return working, especially on lines without telephonic train-control, as the arrival of the engines was often a matter of conjecture. The shortage of rolling-stock was also accentuated by these troubles, especially in the case of passenger rolling-stock, and trains had sometimes to be cancelled as there was no rolling-stock available.

The foregoing may sound humorous, and has often been told with amusement by tourists to China, but this explanation of the causes will, I hope, remove the impression that the cure was simple : it was a condition brought on by several separate but interlocking circumstances, and it seemed impossible to avoid one without incurring another. To slow all trains down in an endeavor to ensure better punctuality sounds simple, but to do so would have accentuated the shortage of rolling-stock, as the miles per carriage per day would have been decreased, and consequently more over-crowding would have resulted. To reduce the loads of the engines would have had the same effect. To raise the speed of the trains required new sleepers, and to improve the reliability of the engines required new boilers and equipment. It was a position which had no outlet except cleverness in scheming the time-table in order to allow the more important trains clearer movement and less possibility of delay by less important trains.

The Traffic Department quite early after the wars reduced the unloading time of a wagon (even the standard 40-ton wagon) to six hours, and applied stiff penalties if this time was exceeded. This improved to some extent the turn-round time of wagons, and the plan of running goods-trains by night instead of by day improved it still further. The " wagon-ton-miles per wagon-day, per wagon in service," which is one of the most vital statistics in railway work, has, therefore, correspondingly improved, and this has done something to alleviate the shortage of wagons, which is, however, still a chronic condition on the average Chinese railway. There is no doubt, nevertheless, that the utilization of wagons can be still further improved, and this applies with equal force to locomotives and carriages.

The other departments can be passed over, as their condition, though interesting to the expert, is hardly so to the layman. The rates and fares also, which steadily increased through the years, will also be omitted, though they are of great interest, especially in regard to the throttling effect which high rates had upon what might have been promising freight traffic had there been wagons to carry it and a rate which made it profitable.

The general situation, therefore, was that the railways were being gradually rehabilitated from their own revenues, despite a great many adverse factors which have already been touched upon. In doing so, however, it had been inevitable that no money was available for the payment of many of the material debts and of the bond amortization, and sometimes even the interest. This was regrettable, not only because it depressed China's credit, but also because the unpaid debts were steadily increasing in amount, many of them at heavy compound interest. Unless some agreement could be reached, therefore, it was only a matter of time before the sum of indebtedness rose beyond the maximum that the railways could pay, despite the most efficient management. Had this been allowed to happen, repudiation of some sort would have been hard to avoid, as the only alternative would have been a foreign loan on such onorous terms that its full observance would have been difficult.

The Boxer Indemnity Fund

Fortunately at this time the Trustees of the British Boxer Indemnity Fund commenced to invest on a large scale in Chinese railways. The return of the British share of what is commonly called the Boxer Indemnity took place in 1931 and took the form of the creation of a revolving fund in China, the principal of which was to be invested in productive enterprises, the interest to go to educative and cultural enterprises. To administer this fund a Board of Trustees was created. The agreement further provided that the accumulated funds and half the future instalments should be expended in the British Isles, while the other half of the instalments should be expended in China or Britain. To conduct the expenditure on goods in Britain a Purchasing Commission was set up with wide powers.

The Chinese Government made an allocation of the funds to the various Government Departments, the lion's share going to the railways. It should be noted, however, that, though the various sums were earmarked for various Government Departments and other enterprises, the investment of the funds remained strictly at the discretion of the Board.

A considerable number of rehabilitation loans for the railways were made, including new locomotives, carriages, and wagons for the Tientsin-Pukow, new rails and locomotives for the Kiaochow-Tsinan line, new bridges for the Peiping-Liaoning, etc. A train-ferry across the Yangtze River was also installed, and this increased the revenues of the adjoining railways, especially of the Nanking-Shanghai, very materially. These rehabilitation loans were, however, subsidiary to the main venture, which was to complete the building of the Canton-Hankow line, which had been building for almost forty years, but had never been finished.

It may have been noted that the Indemnity Fund arrangement, while it provided goods in England, did not provide cash in China beyond the future annual instalments of the indemnity. As railway construction requires both cash and material, the problem was to turn the materials from England rapidly into cash. This was effected by the above-mentioned material loans to other railways.

Another line built at the same time partly with funds provided by the Board was the Hangchow-Kiangshan-Yushan Railway in the Province of Chekiang.

The actual assistance given by the Board to the Chinese railways was great, but perhaps a still more valuable service was the fillip given to public confidence in railway investment. For the first

time the Chinese banks began to consider long-term railway investment in a favorable light, especially when, as in the case of the Hangchow-Yushan line afore-mentioned, they were in partnership with the Board of Trustees. At the same time the gradual emergence of the world from the financial depression caused renewed interest in China as a field for investment, despite the constant pressure from the north, where the loss of Jehol and Chahar provinces was followed by the partial divorce of the northern provinces, including the cities of Peiping and Tientsin, from the Chinese national authority. The Fukien revolt, however, made capital extremely cautious for a time, despite its dramatic collapse. The independent attitude of Canton and the so-called Communists in Kiangsi had likewise a chilling effect. Later the clearing of the Communists out of Kiangsi had an excellent effect on public opinion, and since that time public confidence has not had many setbacks, the principal ones being friction with Japan on more than one occasion, the short-lived revolt of the Kwangsi generals, and the detention of General Chiang Kai-shek in Sian. The outcome of each of these crises has been a strengthening of the authority of the National Government, and the union with Canton in particular has been of excellent augury for the future.

Recent Railway Development

The clearance of Kiangsi made the extension of the Hangchow-Yushan line westwards across Kiangsi very desirable in order to bring back prosperity to that province. Roads had already been driven across it, but a railway was of still greater service, as can be imagined. This line was financed partly by the Provincial Governments concerned and partly by a loan from German sources. The same sources are now supplying funds to extend the line still further to join the Canton-Hankow line, and eventually the line is planned to proceed still further to the west to Szechuen and Kweichow provinces.

Other lines which were projected at this time and which are now being actively pushed on were the extension of the Lung-hai westwards to Sian and beyond. Construction of this line never quite ceased even in the worst years, though it sometimes paused for a time. This line will in time go westwards to Lanchow, and so eventually into the far west of China. A branch from Sian will, however, go south-west to Chengtu, the capital of Szechuen. Both of these lines will traverse loess country and are likely to be difficult pieces of construction.

A line built in 1934-35 was that from Nanking to Wuhu, further up the Yangtze. At the latter place it connected with a line which had been commenced many years ago, but had only started operation the year before to as far south as Sunchiapu, though not as far as the coal seam which was the object of the original promoters of the line. The notable point about this line is that it was built by a Chinese railway company financed by Chinese banks. It is a sign of China's progress that, whereas Chinese railway companies were formerly almost invariably unsuccessful, the present venture has succeeded. This line will now be taken over by the Ministry of Railways as part of the new trunk line from Nanking to a junction with the line running from Hangchow westwards to the Canton-Hankow line. This line when complete will form the main route from Nanking and Shanghai to Canton.

Returning confidence in Chinese railways was exemplified when the British and Chinese Corporation came to terms with the Ministry for the issue (in Shanghai) of a new loan for the construction of the final section of the Shanghai-Hangchow-Ningpo Railway to connect up the two latter towns. This line is comparatively short, but has two large estuaries to cross, and the Chien-Tang bridge at Hangchow, which is being separately financed, will be a magnificent structure of sixteen spans.

On the north side of the Yangtze River, at Wuhu, a line was built two years ago to Lo-Ho on the Huai River to carry coal from the mines to the Yangtze. This line, built by the coal company, has been very successful, not only as a coal line, but also as a passenger-carrying line.

Another line, built in 1935-36, is the Shansi Provincial Railway. This line was built by the Shansi provincial authorities as a light railway of meter gauge connecting with the meter-gauge Cheng-tai Government Railway. This provincial line has been completed southwards to Pochow on the Yellow River, but the extension northwards to Tatung, on the Peiping-Suiyuan Railway, is still under construction.

To complete the account of the new railways I will mention here the new Szechuen Railway from Chungking to Chengtu. This is being built by a Sino-French Railway Company, which is a novel venture, and the success of which will be watched with interest. Another line now being surveyed is a line from Canton to Swatow in Kwangtung province. This may one day be extended north-east to form a trunk railway, but that time is not yet. In the north a line which has been long projected, and the earthwork for a portion of which has been long prepared, is the railway from Shih-kiachwang eastwards to the Tientsin-Pukow line. This will give a better ocean outlet to the excellent coal produced by Shansi.

Projected lines are many, and include the completion of the Pukow-Sinyang, which was commenced before the European War; the Hankow-Ichang line, construction of which was stopped for the same reason; and the Tsinan-Taokow line, etc.

To revert to the condition of the railways three years ago. It will be seen that the revival of confidence, mainly as a result of the action of the Board of Trustees, had eased the financial position of the railways, but, despite the establishment of sinking funds, the mountain of debt grew steadily until several Chinese officials despaired of ever paying it off, and ideas of repudiation began to be entertained, albeit by a small majority.

It was at this time that General Hammond came to China to report on the condition of the railways to the Chinese National Government. His report was delivered to the Government and was not for publication, but his remarks and comments while in China had the effect of giving some of the officials more confidence in themselves, and this was enhanced by the visit of Sir Frederick Leith-Ross, who was instrumental in initiating some of the conversations which resulted in modifications of the Loan Agreements and contracts whereby it became practicable for the railways to pay off remaining arrears in time. This was a fortunate settlement, as it scotched any ideas of repudiation such as had always been entertained by extremist opinion which held that the railway loans had been forced on China against her will, and that she was under no moral obligation to repay these sums if she could in any way get out of it. With the spread of a wider outlook, however, these ideas, which are the result very largely of anti-British propaganda, at one time very prevalent throughout China, are dying away, though a tendency on the part of the British to explain themselves a little more fully would do no harm.

The Ministry of Railways throughout the whole of the time from 1931 had before it several cardinal rules. The first of these was that there was no hope of obtaining a rehabilitation loan from foreign sources which would be in any way acceptable to the Chinese; until the railways could show the world that they were a sound investment, investors, both Chinese and foreign, would be shy of investing money in anything but short-term loans with personal security.

The second principle was that the offer of any foreign syndicate to take over and operate one or more of the national lines, paying surplus profits to the Government, would not be acceptable, partly owing to the feeling that such an arrangement would be derogatory to China's dignity, and partly to the difficulty of protecting the railway from interference by military on transfer, and also by bandits, who would be certain to gather round a company-owned line in the hope of being bought off (It should be noted that this opinion dated from some years ago).

The employment of foreign railway officers on the various lines was also not considered with much favor except by a few. It was not always fully appreciated that the foreign officer being free from politics could often be friendly with everyone, whereas few, if any, Chinese officers could be so independent. Those few foreign officers who remained on the lines had in some measure been short-circuited, and the change in the official language from English or French to Chinese had greatly restricted their capacity, as few of them had had the time to learn Chinese characters, and this placed them in the hands of their translators.

The worst of the situation was now past, and the railways were nearly all feeling the good effects of the improvements made by re-sleepering, the purchase of locomotive spares, general stores, etc. The workshops were still in serious arrears with their repair of locomotives and rolling-stock, but even they were slowly overtaking the arrears, and the backward lines were being increasingly helped by the lines in better condition, in so far as repair of locomotives and wagons was concerned. Later the Ministry decided to place the principal workshops of the country under its own control in order to

prevent overlapping of work, and this should have excellent results when it is fully applied.

Standards

In the work of adopting standards, the Ministry had continued the work of its predecessor, the Ministry of Communications. The standards adopted by the latter organization were of rather a general character, with some exceptions, notably the standard 40-ton wagons which had been designed and adopted complete. The Ministry of Railways endeavored to avoid adopting too rigid a standard, and for a start at least endeavored to standardize essential parts such as tyres, bogie trucks, brasses, etc., while for locomotives in place of standard engines the endeavor was to adopt standard boilers, wheel centers, tyres, axle-boxes, axles, piston-valves, pistons, etc., which in time would approach nearer and nearer to a standard engine. Factors which directed this policy included that of avoidance of obsolescence of design owing to the rapid progress in locomotive design which was and is being made throughout the world. Secondly, the large variation in conditions, climate, grades, etc., in such an immense area as China made it essential to vary the type to suit each case, as well as to suit the loads to be hauled and the speed. A large number of standard types would therefore be essential, and these types would be split up in small quantities on the existing railways amid locomotives of similar but non-standard design for which different spare parts would be needed.

Unless, therefore, a very large number of engines of the same type were required, the advantages of the standardization of whole locomotives would be lost, and the lesser method of standardizing details was consequently advisable.

At the same time the Ministry was and is awake to the latest improvements in locomotives, and these are incorporated in locomotives whenever conditions permit. High steam pressure, high superheat, large boiler, ample fire-box volume, big grate area, large diameter driving wheels, large piston-valves, extra long valve travel, light reciprocating parts, large main steam-pipes, poppet-valve regulators, and other modern points are all adhered to, though sometimes modifications are introduced to permit the engines to be driven on the new lines by pioneer drivers who have often little training.

In passenger cars the all-steel car has been adopted for main-line stock, though a secondary standard with steel frame and wood body may be used for branch and less important lines. The all-steel car is undoubtedly safer in accidents, but the cheapness of the wood-bodied car is in its favor, especially when capital is dear, and, provided that it is fitted with anti-telescoping girders at the ends, is quite satisfactory. These girders are now fitted to nearly all the new wood-bodied stock, and no case of telescoping has so far occurred.

The standard bogie truck adopted is of the American type with full-elliptic bolster springs and triple helical equalizer springs. It is costly, but is found to give excellent results. The axle-boxes are of Isothermos type, as are those for tenders and carrying wheels, as these boxes have been found to give satisfaction.

The cars are fitted with pivoted-head couplers for ease of coupling on curves, and have a large combined buffer and gangway footplate above them which, when fitted with duplex springs, keeps the couplers tensed and thus avoids jerks when starting. The cars are also fitted with all-steel vestibule diaphragms, which are stronger, cleaner, and ultimately cheaper than the canvas bellows fitted elsewhere.

The standard wagons adopted are of the 40-ton type and generally follow American practice. Their design dates from 1921, but though later designs have various small improvements, it has not been thought advisable to amend the standard in any way so far. The wagons are of four types: covered, high-side, low-side, and flat, and there are minor differences between the details of each type, though all essentials are interchangeable.

As a final note it might be said that the organization of the Ministry differs from that of the railways inasmuch as while in the Ministry the running is separated from the mechancial engineers section, on the railways the Locomotive Superintendents combine running with shops (on the lines on which the Ministry has not taken over the shops). The transportation system has been tried for some three years on the Peiping-Liaoning, but did not prove very successful for various reasons, and the older system is now restored. Actually the railways are but sections of one large system, and if so regarded there is no real anomaly in the foregoing arrangement.

World Steel Trade

THE world's steel trade has changed greatly since the Great War, and it seems to be in process of still more changes. Hitherto the production of steel on a large and economical scale has been confined to two areas—Western Europe, including Great Britain, and the United States of North America. Now the United States, holding by far the biggest steel manufacturing capacity, is nearly blotted out of the picture as an exporter of steel, by reason of inflated wages and extremely high cost of transport from far inland works to shipping ports, and shipping freights to overseas markets. The U.S.A., with nearly half the world's productive capacity in steel works, is completely beaten by much smaller countries—by Germany, Britain, France, and Belgium—in exports. Since the American Steel Trust was formed, in 1901, with the object of cheapening production and underselling European steel in world markets, the United States has dropped from a highly promising second place in exports to a very poor fifth position.

While America has fallen behind in the international competition, another competitor is coming forward. As a producer Russia is forging ahead, but wants, and is long likely to want, for her own uses all the steel she can produce. Russia does not count as an export competitor. Japan is the coming rival in neutral markets. The cost of producing pig iron, the foundation material of the steel industry, was reduced from about £5 a ton to £2 a ton between 1908 and 1918, and has been still further reduced since 1918. Japan is forging ahead as a producer of steel, and it seems more than probable that she will very soon become a formidable competitor in the export trade. She has good reserves of coal suitable for making furnace coke. She has fairly good reserves of iron ore. She has practically annexed the immense ore reserves of China. Japanese competition in steel, in engineering products, and in steel ships, is developing rapidly.

Cost of labor comes second only to natural resources. In this vital matter Japan holds a wonderful advantage. We hear much about South Africa as a coming competitor in steel. In South Africa skilled labor in iron and steel works costs nearly £6 per man-week. In Japan it costs £1. The president of the American Iron and Steel Institute, Mr. W. A. Irvin, who is also president of the United States Steel Corporation, has figured it out that steel industry wages stand as follows, per man-hour:

United States	67 cents.
Germany	26 ,,
Britain	25 ,,
France	20 ,,
Belgium	17 ,,
Japan	10 ,,

To this calculation, which cannot be far wrong, if wrong at all, there stands to be added cost of transport from works to ports of shipment. In this respect United States steel manufacturers are in the worst position. Iron ore in America has to be carried a thousand miles from mines to blast furnaces—two rail hauls and a long lake voyage. When the American pig iron is converted into steel, and the steel into finished products, the products have to be rail hauled at least a few hundreds of miles before they can be shipped. The average all-in inland transport cost of American steel for shipment is 200 per cent more than the corresponding British cost. In Great Britain there are short hauls from mines to works and works to docks.

Air Conditioning in a Hongkong Bank

By C. A. MIDDLETON SMITH, M.Sc., M.I.Mech.E., Taikoo Professor of Engineering, Hongkong, in "The Engineer"

Although in Britain manufacturers of apparatus for removing excessive atmospheric humidity are now beginning to realize the possibilities of a great increase in the demand for their products, engineers in America seem to have appreciated the importance of the subject several years ago. The climatic conditions of the Southern States and the close contact of communities in the North and South of the United States, no doubt account for that fact. But there are enormous areas in the Dominions and Crown Colonies, and markets in other tropical lands, that will inevitably demand air-conditioning equipment. It is hoped that British firms will consider these markets. Several manufacturers now provide suitable appliances. The extended use of them will accelerate the economic development of tropical lands.

The mechanical production of cold has created, during the last half century, an enormous industry concerned with the preservation of food. There is the certainty of another great industry, based upon the mechanical production of cold, used to remove water vapor from the air. The demand will come, not only from the extension of certain industrial processes in which fairly dry air is essential, but from people who will demand comfort in their offices and homes when they know it is attainable.

Air-drying Methods

A letter from Paris contained particulars of a purely chemical process by means of which manufactured weather can be contained. Useful as chemical processes have been proved to be, in practice refrigerating machinery has been much more generally used for drying air. Mechanism not only dries but cools air ; chemicals only dry it. Although chemical methods, using the regenerative principle, have been proved to be of value in certain industries, it seems probable that in the long run the compressor and electric motor type of plant will be more in demand for this purpose. The mechanical method will provide more employment for the engineering industry, in connection with air conditioning, than absorption processes. With modern compressors of any size required for a building to be air conditioned, the ratio of the heat units that can be abstracted by mechanized cooling plant to the equivalent in heat units of the power used to drive the machinery, is much greater than the corresponding ratio in a regenerative and absorption system using chemicals. On the other hand, every encouragement should be given to those who market these chemical processes, as they are of value for air conditioning small rooms and for use in places where electric power is not available. And their value when used on a large scale in at least one industry has been proved. These chemical absorbers of moisture in the atmosphere appear to have received more attention in the U.S.A. and France than in Britain.

A valuation contribution on this subject was made by Mr. E. H. Lewis in a paper read before the Iron and Steel Institute in September, 1927. He described the results obtained by employing *silica gel* as a medium for drying air supplied to blast-furnaces at the works of the Glasgow Iron and Steel Company, Ltd., of Wishaw. These results showed that important economies may be achieved in a saving of fuel, increased output, and the production of a more regular quantity of iron. The air dehumidified measured 35,000 cubic feet per minute, which is about the amount required for a cinema to seat 1,100 people.

The importance of water vapor in the atmosphere in connection with this industry will be realized when it is explained that 0.5 grain of water vapor per cubic foot of air in the blast represents about 10 lb. of water per ton of pig iron made. Refrigeration methods—the Gayley process—have been used in the U.S.A., at Cardiff, and in Germany, but in this particular industry chemical absorbers appear to be more economical.

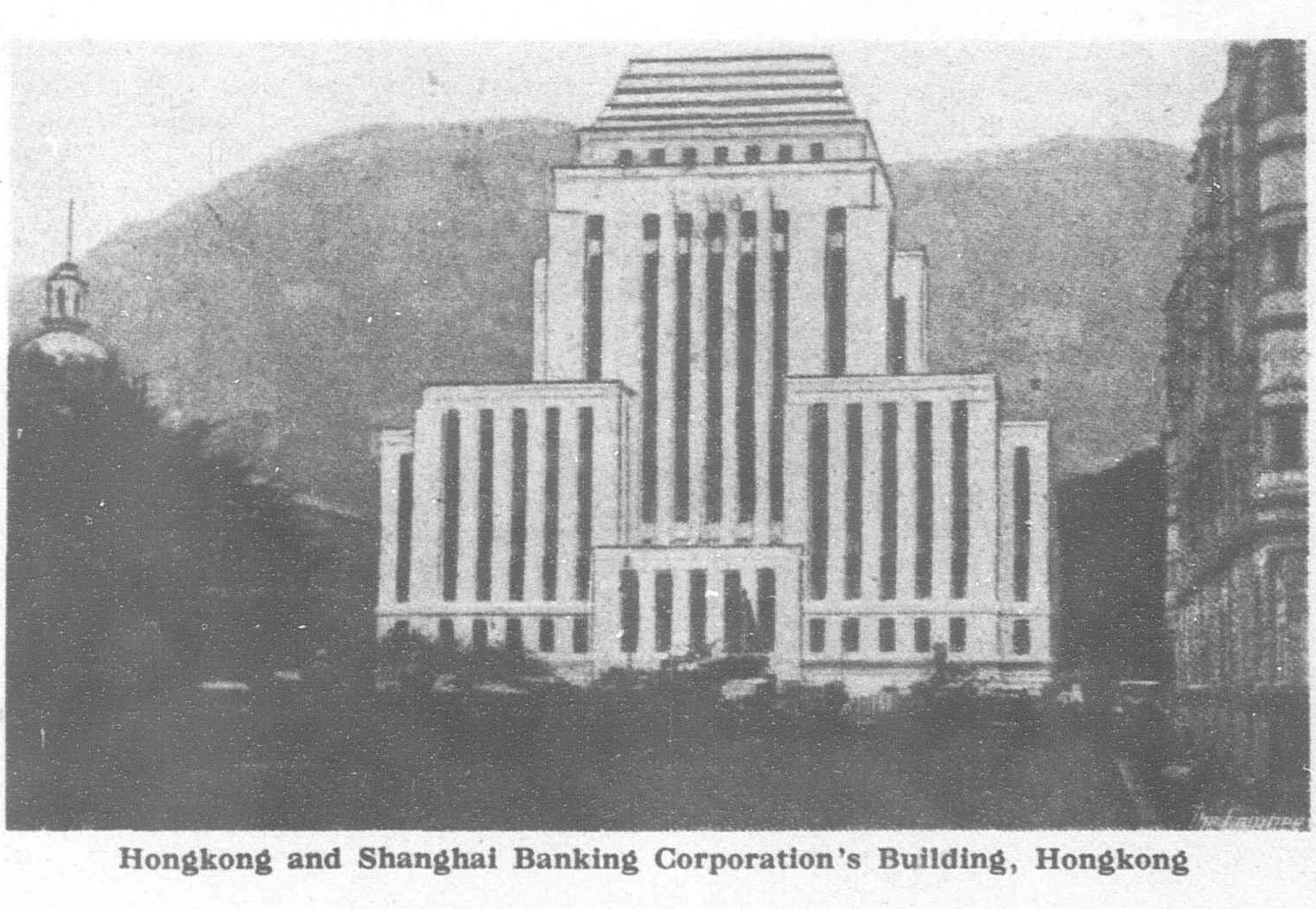
Mr. Lewis gave figures as high as 6.51 grains of moisture per cubic foot of atmosphere during July, 1927, at Wishaw. Incidentally, it may be mentioned that in Hongkong in the summer months we often have the atmosphere at 86 deg. Fah. saturated (i.e., relative humidity 100) with 13 grains of moisture per cubic foot of dry air ; and at times, with higher temperatures, more grains of moisture. These high temperatures and humidities naturally increase the cost of air conditioning.

Distinguished medical scientists have considered the subject of air conditioning. Engineers must have read with interest the recent contribution to *The Engineer* by the eminent physiologist Sir Leonard Hill, F.R.S. His invention of the Kata thermometer was a notable event. It provided a method of accurate measurement—the basis of scientific progress.

The Conquest of Lethargy

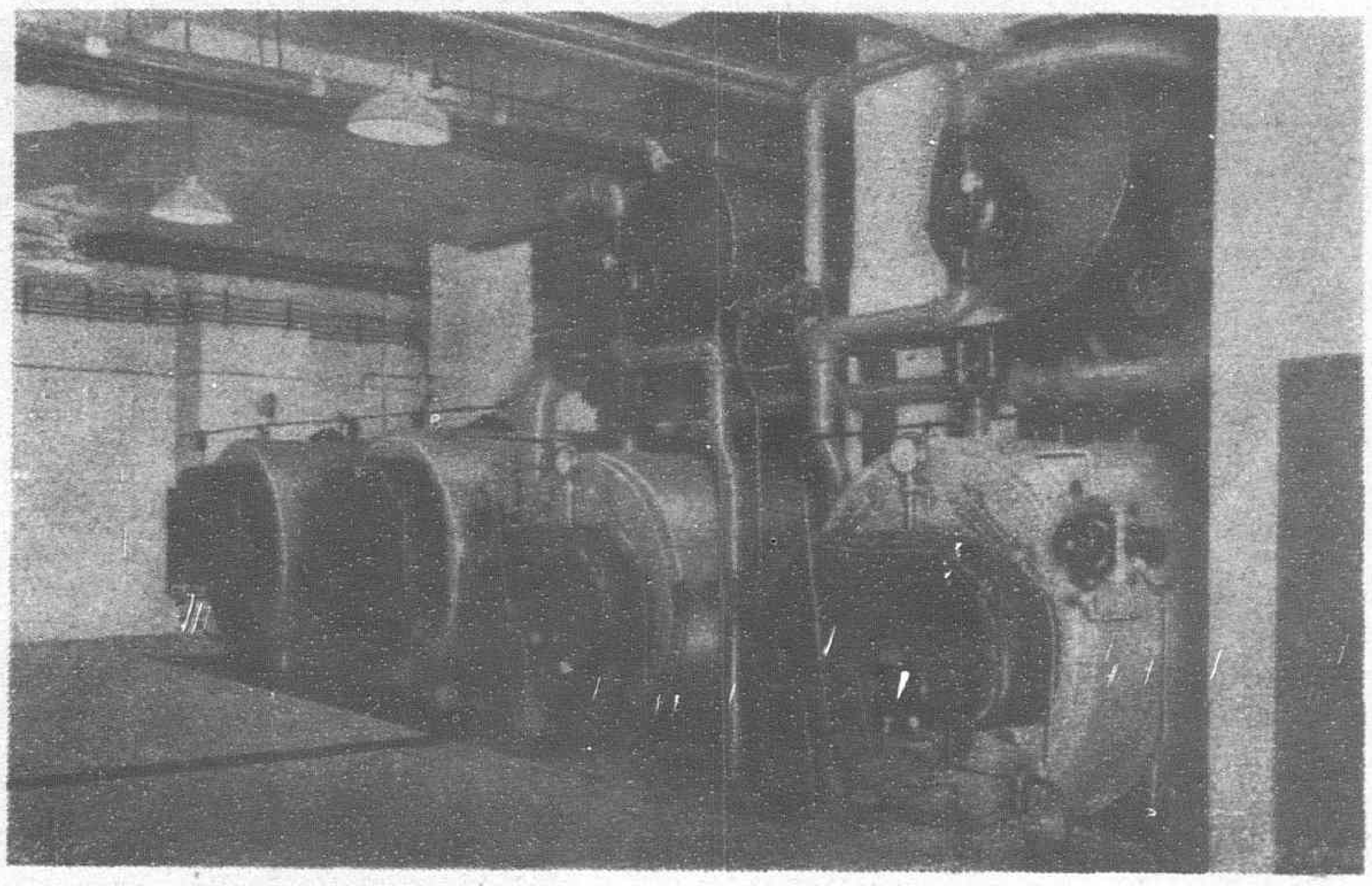
It was not until the writer lived in the tropics that he realized how great is the effect of atmospheric conditions upon human energy and enterprise, and how important to mankind is the conquest of one of the chief causes of the human intellectual and physical lethargy so apparent in an excessively humid climate. That lethargy astonishes the energetic Englishman when first he works in the tropics, but he soon falls a victim to it.

Observation and experience, during nearly a quarter of a century in Hongkong's (summer) hot and humid climate, convinces me that there is a great decrease in mental efficiency and an increase in intellectual and physical lethargy when atmospheric conditions rise above certain limits of temperature and humidity. The effect upon health seems to vary considerably ; but many Europeans are compelled to return at fairly frequent intervals, and for a period of months, to more temperate climates, to regain health and vitality. European women seem to suffer from the effects of climate in the tropics more than men.

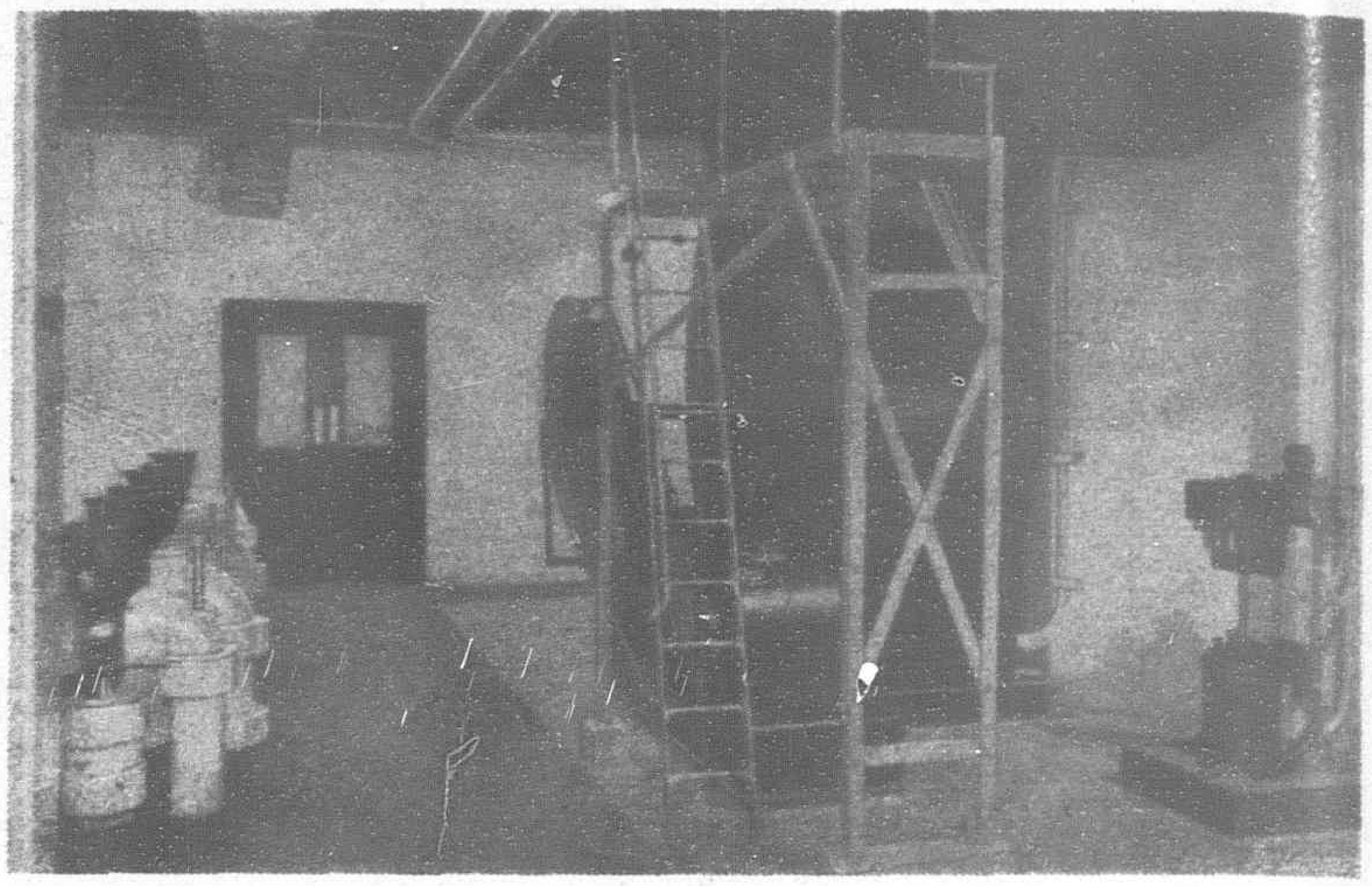


Hongkong and Shanghai Banking Corporation's Building, Hongkong

Those facts greatly impressed me after a short residence in Hongkong, and led me to consider in detail possible methods of eliminating the excessive moisture in the local atmosphere. A number of experiments and calculations made twenty years ago caused me to realize that any effective installation for



Boilers and panel warming, air conditioning and water supply



Main suction fan

a large building in the tropics would be expensive and complicated; but they also convinced me that if the results obtained were realized there would be a big demand for these installations in countries afflicted with a hot and humid atmosphere.

During a long leave in England in 1927, the opportunity to do research work in this subject in the University of Birmingham brought me into contact with a prominent physiologist, the late Professor J. S. Haldane, F.R.S. His scientific researches concerning the welfare of miners had included a consideration of air conditioning underground. The great importance to humanity of this subdivision of applied science was then impressed upon my mind, for facts concerning the reactions of humans to excessive humidity were provided by Dr. Haldane, who had been elected President of the Institution of Mining Engineers, a unique honor for a doctor. It proved that mining engineers appreciated the value of his welfare work on their behalf.

There has been a great deal of progress since 1927, especially by manufacturers who now offer equipment capable of creating an ideal atmosphere in offices and in homes in almost any part of the world. The experience obtained with these installations in Hongkong, and even in parts of China not in the tropical zone, is most encouraging.

People who have experienced for a short time the comfort of a manufactured climate in this part of the world have been stimulated to consider their own individual problems concerning the adoption of this method of improving atmospheric conditions in the buildings in which they work and live. Unfortunately, a great deal of confusion of thought on this subject exists in the minds of the public, and even many engineers fail to appreciate the vast possibilities of a comparatively new industry. It is astonishing that even educated Europeans are ignorant concerning elementary science.

A Pioneer Installation

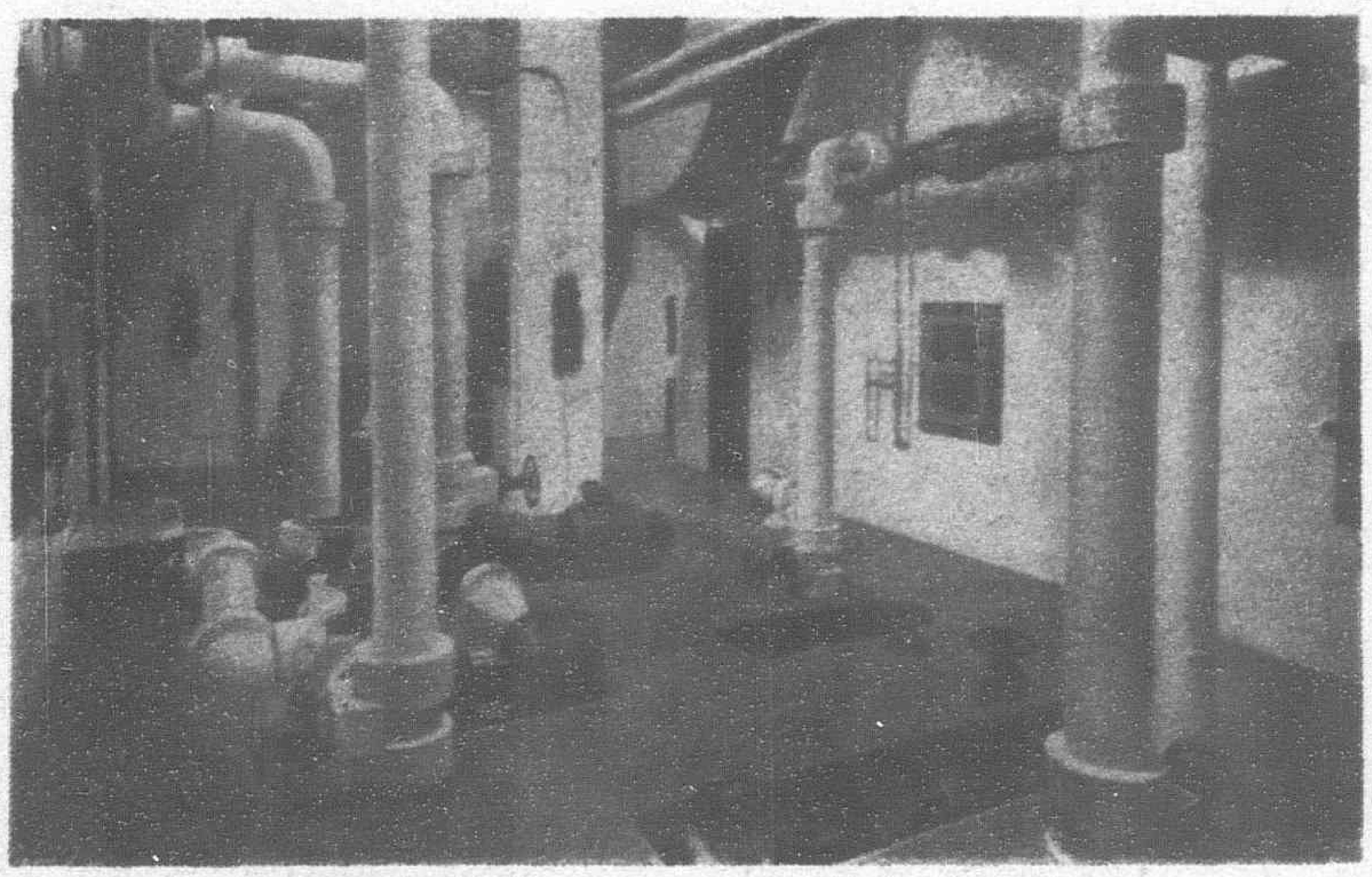
The attention of the Hongkong public was first directed to the subject of air conditioning when they entered a new cinema where there is seating accommodation for 1,100 people. In England cinemas are ventilated; in Hongkong this cinema is not only ventilated, but air conditioned, and so was able to provide the audience as early as 1934 with a much more pleasant atmosphere than any other place in the Colony. The equipment for air cooling and air drying cost about £6,000; it consists of, ammonia compressors, with a total of 190 E.H.P. electric drive, a 25 E.H.P. pump for circulating water for the ammonia condensers, a 25 E.H.P. pump for circulating the cold brine, a 10 E.H.P. pump for the spray water, and 15 E.H.P. pump for fan delivery. Thus the total E.H.P. is about 265 for the whole plant. The load on the plant varies from a maximum—usually in August—to zero in the winter months of January, February and March. The maximum cost for electric power for one day was about £1, but the average is much lower for the whole year—say, about 10s. a day.

From a careful examination of the records taken for this installation the writer estimates that it costs, on the average, an outside figure of £3 a day throughout the year, or, say, £1,000 per annum. That includes interest and depreciation on buildings, plant, etc., as well as wages and running costs. Current for power is supplied at about 0.6d. per B.O.T. unit.

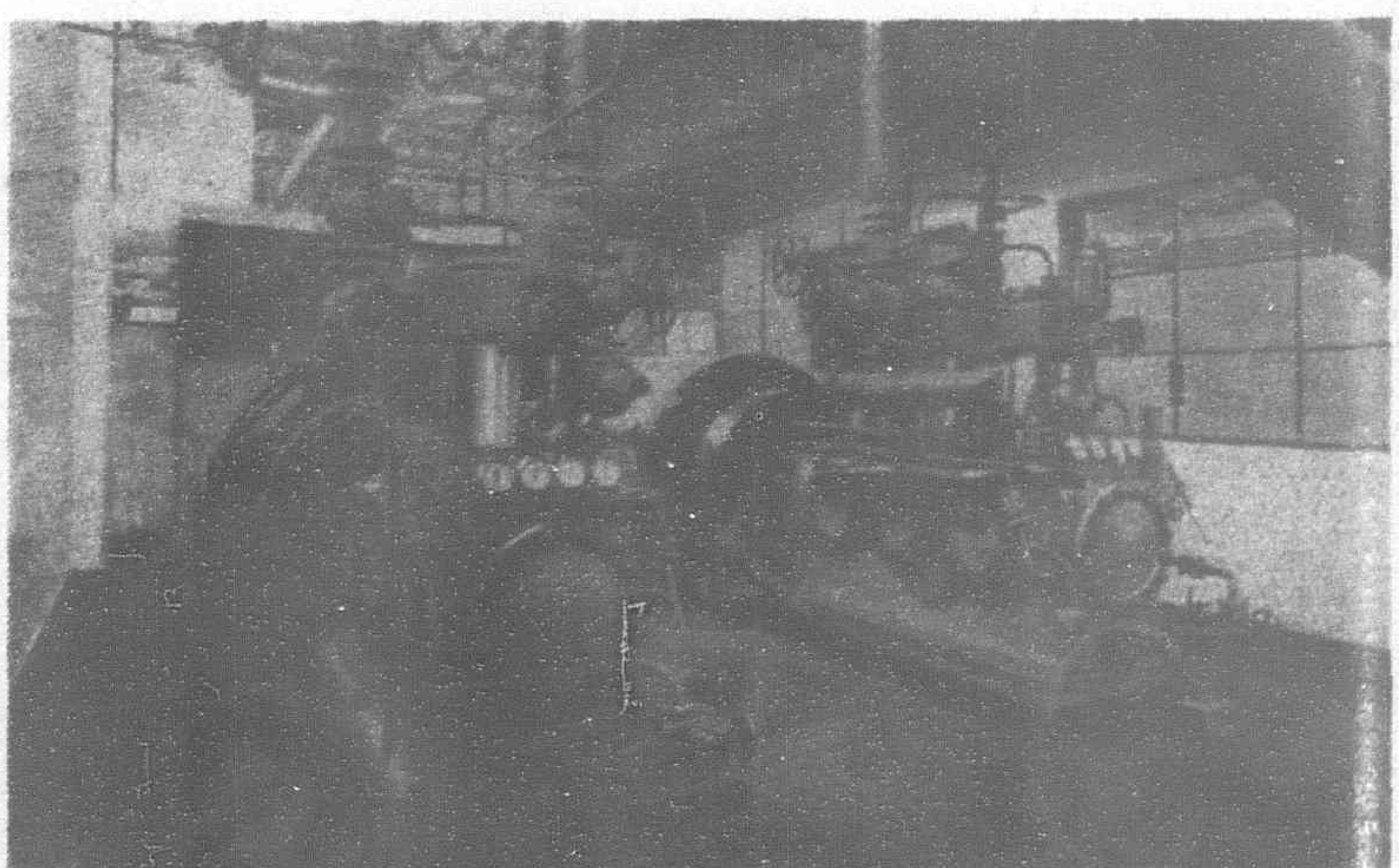
The Hongkong and Shanghai Bank Equipment

The largest contract for equipment to provide ideal and stable atmospheric conditions all the year round, in a building in Hongkong, totalled about £100,000. This installation is the largest in the Tropics known to the writer. The plant has been in operation rather more than a year. The experience gained with it is of great value, if only as demonstration to a large number of people of the advantages of the system.

The total volume of the space within the magnificent new headquarters of the premier bank in the Far East (Fig. 5) is very much greater than that of a cinema. It is approximately 2,300,000 cubic feet. The area of the site is 56,000 square feet; the road frontage is 247-ft. The height from road level to the top of the



Pumps and spray water pipes for air washers



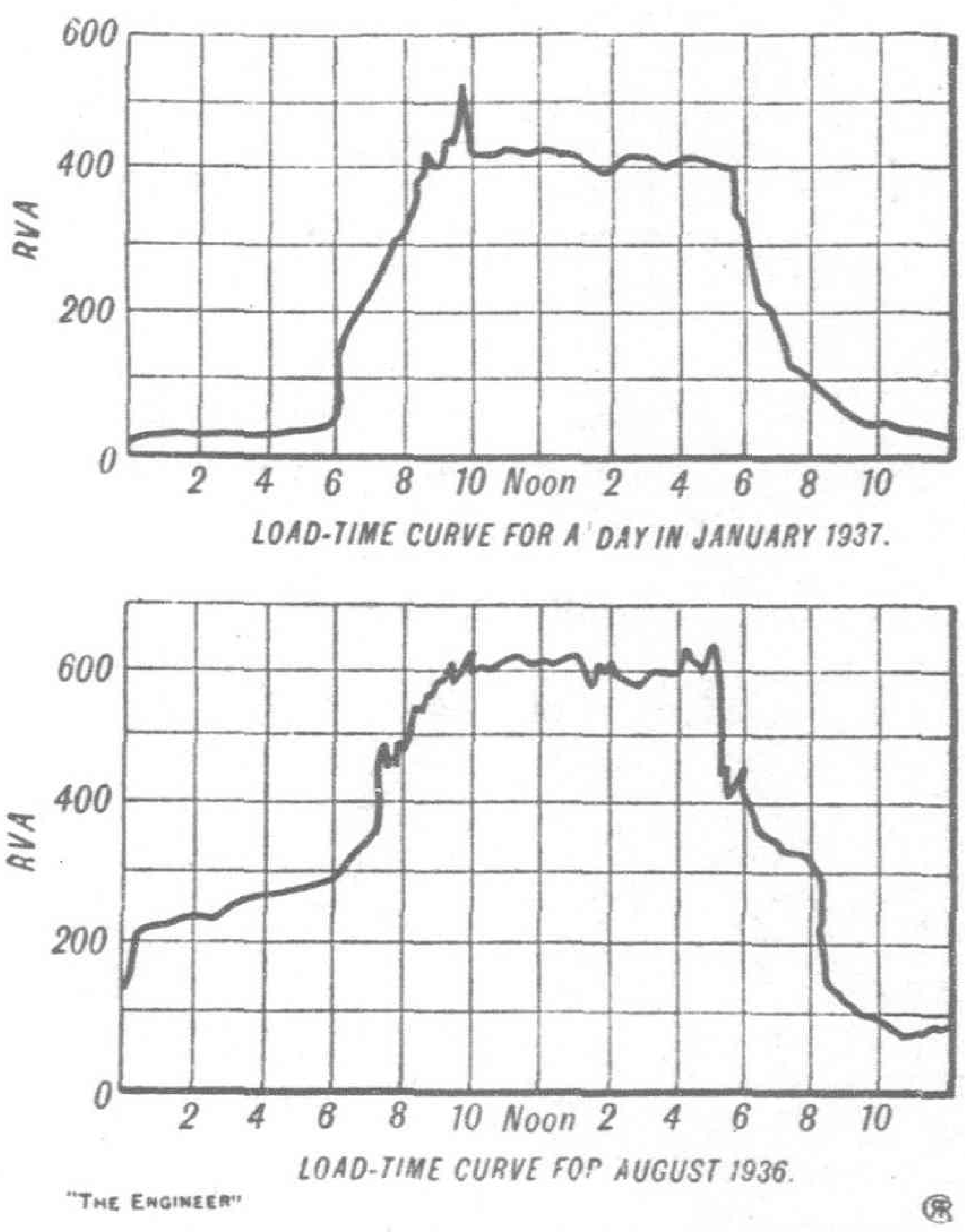
Compressors for refrigerating plant

tower is 247-ft. It included, for the first time in South China, examples of (1) chromodor steel framing, (2) mechanization methods of construction, (3) air conditioning.

There are thirteen floors above ground level and a basement. The building includes a main banking hall, with a floor area 14,600 square feet; the height to the top of the barrel vault over the public space in this hall is 46-ft. There are also offices for rent, residential quarters for members of the staff, etc. There are about 400 people at work each day within the building, and it is estimated that about 100 more pass in and out each hour, most of them through the banking hall. Incidentally, it may be mentioned that the plant power records show a greater load during the first three or four days of each month, indicating that a greater number of persons pass in and out during those days than at other times.

A modern air conditioning plant consists primarily of an air washer to cool and purify the air, a circulating fan to distribute the air to the various inlets to rooms, the air ducts for the supply and exhaust air, and the refrigerating plant to provide the cold water for the air washer.

The whole of the air within the bank building is conditioned and there is constant but unobtrusive ventilation. In the (about) nine summer months, from April to December, the air is cooled, mainly to reduce the relative humidity; in winter, air can be heated by a hot water panel system, designed to give out a maximum of 3,750,000 B.Th.U. per hour. During the winter months the conditioned air is heated before it is introduced into the rooms and the temperature is maintained by the hot water heating panels hidden in the ceiling of each room. G. N. Haden and Sons, Ltd., of Kingsway, London, were the contractors for the plant, all of which was made in Britain. It is illustrated by accompanying engravings Figs. 1, 2, 3 and 4.



Load-time curves of air conditioning plant

It consists, not only of refrigerating machinery and the heating boilers—some of which supply a constant supply of hot water for domestic purposes—but also fans, washers, thermostats, various recording instruments, a long switchboard for electrical control, etc., all of which covers a large floor space.

The general arrangement of the air conditioning plant is as follows:—The compressors, condensers, evaporators, etc., for cooling the water pumped to the air conditioners, three of the six air conditioners, and the boilers for heating water for domestic supply and for air heating in winter, are concentrated in a large engine-room in the basement. Adjoining the engine-room is the switchboard room. The air in the building is conditioned in six sections and, if desired, the different parts of the building supplied by the conditioner (or "washer," as it is often called) in a section can be provided with air of different degrees of temperature and humidity.

In practice all parts of the building are provided with approximately the same atmospheric conditions. The work to be done by a conditioner for any one section to maintain a stable atmosphere when the sun is blazing through the windows is greater or less as it moves away from east to west or as the outside conditions affect convection, conduction, etc. The atmosphere all over the building is kept stable during working hours by automatic appliances regulating temperature and humidity.

Local Working Conditions

Under normal routine conditions of work in the building the conditioners supplying air for the main banking hall, offices, etc., are at work for about twelve hours a day, say, from about 6 a.m. to 6 p.m. The conditioner for the residential flats operates more or less continuously. Thus the main load comes on the plant during daylight hours, which vary in length throughout the year very little in the Tropics. The maximum load in any day is at about noon, when the sun's heat is usually strongest and the greatest number of people are in the building.

The conditioners take their cooling capacity from a large quantity of fresh water, in circulation, which is cooled by passing it over the ammonia evaporator coils. The water is reduced to about 40 deg. Fah. This water is delivered to the various water sprayers in the six conditioners supplying air to different sections of the building. These sprayers form a part of the conditioners and can be regulated to give any required air conditions. They have automatic regulators, which can be adjusted to provide varying air conditions, as desired.

The conditioners wash the air in circulation and reduce its humidity and temperature as needed. In winter, hot water from the boilers may be supplied to heating batteries, through which the air passes after leaving the washers.

The six air conditioners for the whole building are all in action during working hours. The conditioner for the residential section is at work continuously. Three conditioners are situated in the central engine-room in the basement. These are built of brick; the outside area is covered with white glazed tiles. They deal with the air in the banking hall, bank offices, and various other rooms of the front of the building up to the fourth floor. The two conditioners on the fourth floor are used for the air in the remainder of the building, except for that required for the offices and residential quarters in the tower. A plant on the thirteenth floor deals with the air for that section.

Circulating fans give out heat. That given out by the fans in the basement does not give extra load on the plant, as the air in the basement is thrown away to outside air. All of the NH_3 compressors were supplied by Messrs. J. and E. Hall, of Dartford. They are installed in the basement. Two compressors have three cylinders each. They are driven by 205 E.H.P. synchronous induction motors. Arrangements have been made to use the motors for improving the power factor of the whole load used in the building. Phase compensation causes a gain in the power factor, an important item in the cost of electricity supply. Power supply is taken from the local mains. A smaller single-cylinder compressor, designed to work at week-ends for the air supply to the residential flats, is now seldom used. It has been found more economical to use one working cylinder of a large compressor for light loads.

The total weight of ammonia in the cooling plant is 7,000 lb. No brine is used in the system. The fresh (town supply) water is cooled directly by contact with the evaporator tubes and is delivered to the washers from the cold tank. Small electrically driven stirrers keep the water in the cooling tanks in motion and so prevent ice formation near the evaporator tubes. The condenser sea water circulating system requires 856 gallons of water per minute; two pumps, each fitted with a 27 E.H.P. motor, have been installed. Each pump is a standby for the other. An ingenious arrangement not only allows a pump to be started or stopped by pressing a button in the engine-room, but the alternate use of the pumps automatically alters the direction of flow of the sea water through the inlet and outlet pipes. That is in order to scour the pipes and filters. The distance from the sea to the front of the building is 600-ft., so that the sea water used for circulating purposes travels about 1,200-ft. Under normal circumstances the sea water, screened on entry, rapidly passes through the circulating system and returns to the sea in a few seconds. A terrific typhoon in August last caused a failure of this circulating system, with an unexpected and curious sequel, details of which are given later.

For circulating the cold fresh water from the evaporators to the sprayers there are nine pumps with a total of 121 E.H.P. rating, of which 96 E.H.P. is absorbed. For re-circulating warm water through the air washers during the winter six pumps with a total of 26 E.H.P. rating are provided. It is estimated that they will never use more than 18 E.H.P.

For handling about 10 per cent (or a total of 229,000 cubic feet) of air in the building in circulation per minute six circulating fans

have been installed. For this purpose motors, totalling 162 E.H.P., have been provided, but the maximum load is 126 E.H.P. There are various other fans—twenty-three in all—for the building, absorbing 141 E.H.P., but with a total rating of 180 E.H.P.

The following list gives the deliveries of the fans in cubic feet per minute and the air spaces in the six sections of the building supplied.

AIR SUPPLY FROM CONDITIONERS

Fan No.	*Name of section*	*Air delivered c.f./m.*	*Air space of section*	*E.H.P. of fan motor.*
1	Bank executive office	24,000	141,000	20
2	Banking hall	50,000	890,000	40
3	North office	36,000	300,000	30
4	E. and S.E. offices	26,000	132,000	17.5
5	W. and S.W. offices	45,000	255,000	32
6	Fifth to eleventh floor offices and flats	28,000	300,000	22

All of the above fan motors are of the three-phase slip-ring type. There are seventeen auxiliary fans for various duties, such as delivering air to the workshops and extracting air from kitchens and lavatories. The motors for these fans are squirrel cage, and range from 5 E.H.P. down to 0.5 E.H.P. As explained later, none of these fans supply air to the space in the basement and silver vaults, which are ventilated by exhaust air from other parts of the building.

The gratings through which the air passes into and out of each room are so placed as to ensure thorough circulation of the air without giving rise to draughts. A quantity of air corresponding to that admitted is extracted from each room. Thus the air of the room is in motion, which assists its cooling effect, but the occupant of the room is practically unaware that the air is in motion. Although the cooling effect of air in motion increases with the velocity, the area of escape of the inlets to offices should be as large as possible to prevent draughts. Dampers should be fitted in all offices to allow individuals to regulate air inlets as they fancy. Most of the extracted air is returned to the unit to be reconditioned, but a part (about 0.8 per cent per minute) is discharged to the outside atmosphere via the basement and vaults.

A quantity of fresh air equal in amount to the vitiated air discharged is passed to the conditioning unit through a special filter which removes all dust. The waste air discharged is used to ventilate the engine-room, etc., in the basement. Thence the air is passed through the strong rooms (or vaults) containing silver, so that the maximum advantage is obtained from even the waste conditioned air, which ventilates spaces which otherwise would not be served, because they do not warrant air-conditioning plants of their own.

The air from all kitchens, bath rooms, and lavatories in the building is separately exhausted by special fans and blown to waste.

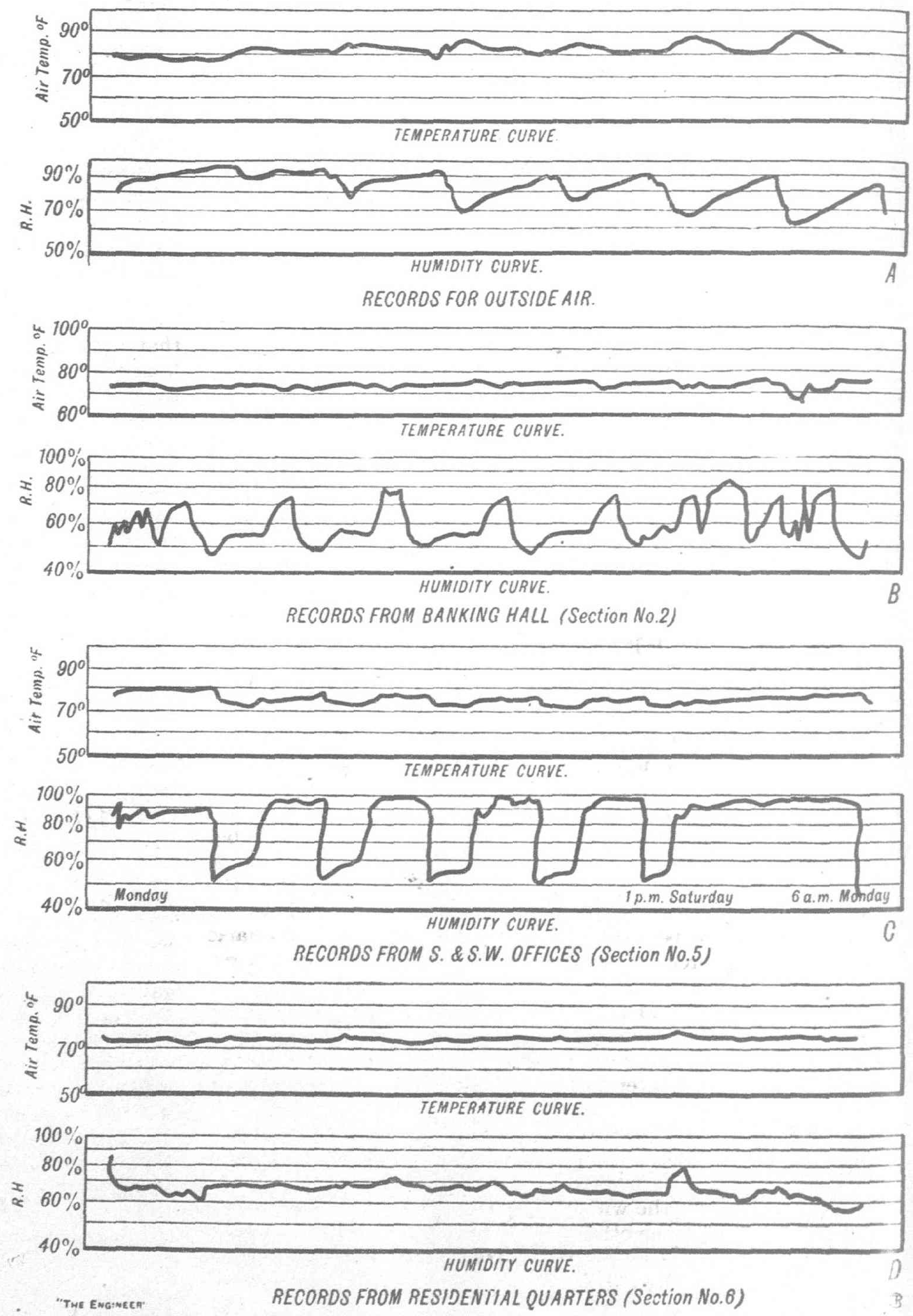
Fresh water for evaporators and conditioners is taken from the local mains. A well was sunk to provide water for flushing lavatories, etc., a special arrangement of a storage tank for sewage inside the building was made, as during a typhoon it is not possible to discharge sewage into the sea, owing to the high tides.

The Saturated Atmosphere

Now let us consider the work which this plant is designed to perform. It was assumed that the extreme condition of the outside air in Hongkong would be 85 deg. Fah. and 90 per cent relative humidity. According to the Carrier psychometric chart, under these conditions each pound of dry air contains 162 grains of moisture. It is desired to maintain the air within the building at a constant condition all the year round, and that the conditioned air shall be maintained at a temperature of 75 deg. Fah. and 70 per cent relative humidity, i.e., each pound of dry air to contain 90 grains of moisture. Thus each pound of conditioned air inside the building must be at a temperature 10 deg. Fah. lower than the outside air, and must contain 72 grains less moisture. In other words, on a day with the above outside air conditions, there would be about 1,750 lb. less weight of water vapor in the air inside the building than there would be if there were no air conditioning. Under such conditions the power load is mostly used for condensing and cooling water vapor.

Each separate air-conditioning scheme involves a large number of variables, and in consequence must be designed and estimated in great detail. The actual fabric losses of the building, the effect of the sun on roof and walls, the number of people working in the building, and the number passing in and out are all factors in the problem.

It must be emphasized that the atmosphere in Hongkong often contains a great deal of moisture. During a year the maximum



Air temperature and humidity curves for various sections

figure (during July), as given by Mr. Lewis at the steel works in Glasgow, was 6.5 grains per cubic foot of atmosphere. In Hongkong there is at times 18 grains of water vapor per cubic foot of moist atmosphere.* There seems to have been success in estimating all of the factors mentioned above, as the Hongkong Bank plant has been able to deal with more extreme conditions than those mentioned above, without any rise in the temperature or humidity of the air inside the building.

Although the volume of air circulated per minute is about 229,000 cubic feet, of that amount the fresh air supply is 18,000 cubic feet, or, say, about eight per cent of the circulated air, the remainder being air from inside withdrawn, cooled, etc., and used again. This new air corresponds to the rate of ventilation required in provincial cinemas in England, but in those cinemas it is not usual to provide air conditioning. The ventilation air used in England ensures that the temperature in the cinema does not rise too much. As air conditioning deals with the heat factor, in the Hongkong Bank building it will be realized that the quantity of outside air provided is generous, and gives a healthy atmosphere, with more than usual ventilation.

When the plant was installed it was estimated that the maximum load required under extreme conditions of outside air would be about 550 E.H.P. That load has often been exceeded. The local records have shown higher humidities and temperatures than were estimated. The extra load has been carried in a satisfactory manner. The plant has now been at work more than a year. At times, in April and August, the months that usually have most extreme atmospheric conditions, the maximum load has reached as much as 650 kva. The power factor varies with the load from 0.95 to 0.91. It is probable that in a new building the walls "sweat," and it will be of interest to see whether after a year or more the maximum and average load lessens.

The Working Load

A study of the records kept by the resident engineer in the bank building made me realize that, even after an experience of twenty-five years in Hongkong, my general impressions of local atmospheric conditions throughout 1936 were not entirely reliable. During the months when the local climate conditions are at their worst, the power demanded by the plant is at a maximum, but there was a greater demand on the NH_3 compressors for a much longer period throughout the year than my impressions of local conditions caused me to expect. It surprised me that it had been necessary in the bank building to run even a small portion of the refrigeration plant during our winter months, during which there are days when we think the climate ideal! But, of course, we forget that the building is almost like a sealed box. About 18,000 cubic feet of outside air per minute are admitted into a building containing 2,300,000 cubic feet of air. That corresponds to 600 cubic feet of fresh air per hour per head on the estimated number of occupants. That fresh air supply means 2,300,000 cubic feet of outside air is sent into the building in just over two hours, but at the same time the occupants of the building are giving out heat and moisture.

The quantity of moisture, heat, and dirt given out into the atmosphere in this building, which is occupied by a large number of people, surprised me.

It appears from the records taken in the building that the worst local atmospheric conditions were in August, and during that month about 260 per cent more power was used than in January. It must be remembered, however, that in January the air is heated, and although heating is not so expensive as cooling and dehumidifying air, the total annual cost of maintaining stable atmospheric conditions within the building throughout the year is not entirely due to the cooling plant, but includes the cost of heating the air supplied during the winter months. That heat is due primarily to oil fired in boilers.

It will be realized that only a part of the electric power consumed each day is used by the NH_3 compressors. At the Equator the daily load would be practically constant throughout the year, but for a short time in the winter Hongkong atmospheric conditions are very pleasant. On the other hand, owing to the granite formation of the hills around the harbor, there are periods when the atmospheric conditions in Hongkong are worse than, say, in Singapore.

It is probable that after some time the average monthly load will decrease. There must be a certain amount of drying out of moisture in the walls of a new building, and this moisture must affect the load on the plant. During the first year or two in the running of any such plant adjustments must be made as the result of experience of local conditions. Taking all these facts into consideration, it seems probable that the average monthly load will be reduced as time goes on.

The diagrams (Fig. 6) give a good idea of the usual routine of working the plant on a typical day in summer and in winter. It is more or less on a maximum load during any twenty-four hours from about 7 a.m. until 4.30 p.m. The peak load is reached at mid-day. After 4.30 the load falls gradually until about 7 p.m., when certain conditioners are cut out, and only those required for residential flats are operated.

During a typical day in the coolest and driest month of the year (January), the maximum consumption of electric power was from 8.30 a.m. to 4.30 p.m., and was about 450 kva.

In August, on a typical day, the maximum load occurred during about the same period, but reached just over 600 kva. It will be noticed that there is a great difference in the demand for power between 4.30 p.m. and 8.30 a.m. on typical days in these two months.

The air temperature and humidity curves (Fig. 7) during a week in August show how rapidly the relative humidity of the air inside the building rises as soon as the plant is shut down, and no conditioned air is supplied to a section.

The curves show the records of temperature and relative humidity (R.H.) taken during the whole of one week in August, 1936, in various parts of the building together with the record of the outside atmosphere. They reveal the fact that the average R.H. for the atmosphere outside the building varied from as high as (almost) 100 per cent (saturation) in the early part of the week, to just over 60 R.H. towards the end of the week. The outside air temperature varied during the week from about 78°F. to 90°F. The maximum air temperature is usually at mid-day.

An examination of corresponding curves for air contained in the various sections of the building, during the same week, shows that although the *temperature* of the air in all sections of the building kept fairly constant night and day throughout the whole week, the R.H. in the sections supplied by conditioners No. 1 to No. 5 varied during 24 hours. The curves show clearly when the plant was not in operation during each 24 hours, for the R.H. quickly increased when the plant was shut down in the evening, and decreased when it came into operation in the morning. There was, however, a great difference in the curves for the big Banking Hall (section No. 2) and for smaller offices (section No. 5); in the latter section the rapid rise in R.H. as soon as the plant is shut down is revealed. The much larger volume of air in the Banking Hall is the reason for the contrast. The extreme right-hand part of the curve shows the high R.H. from mid-day Saturday to Monday morning when the air-conditioning plant was not in operation. The low R.H. shown in the curve was recorded when the plant was in operation.

The curve for Section 6 of the building shows the effect of continuous running of the air conditioner. The R.H. and air temperature curves in that section show that both were kept fairly constant.

Heat from Humans

A cinema is the simplest form of air conditioning, as only one room has to be considered. For a theater of 1,000 seats the air washer or conditioner would be a large steel chamber about 9-ft. long, 8-ft. high, and 8-ft. wide. It would require about 20,000 gallons of water per hour at about 44 deg. Fah. for normal working. Water is delivered to the spray nozzle at about 30 lb. per square inch.

A rough idea of the heat to be removed per hour from such a theater, in addition to the heat which must be abstracted from the fresh air admitted, which must be cooled and dehumidified, will be obtained from the following figures.

Investigations have shown that an adult radiates in the form of latent and sensible heat about 400 B.Th.U. per hour, giving out about 700 grains of moisture by respiration. The heat leakage through walls, etc., in the cinema is about 60,000 B.Th.U. per hour. The heat given out by illumination is about 30,000 B.Th.U. per hour,

* Care should be taken in reading psychometric charts. One chart give the grains of water vapor per cubic foot of dry air; another type gives the grains of water vapor per cubic foot of saturated air.

and the heat of circulating fans about the same. So that a total of 520,000 B.Th.U. per hour is due to these causes, sufficient to melt 3,600 lb. of ice in one hour. In addition, heat must be abstracted from the outside air that is admitted to supply the needed oxygen. In a cinema that may be as much as 25 per cent of the air supplied to the washer, but in a much larger building with fewer people, it is sufficient to have only about one per cent of the air supplied to the washer admitted from the outside atmosphere. All of the above factors vary with local conditions.

Facts and Prejudice

There are always to be found critics of any innovation. There are no fiercer opponents of change than typical " Old China Hands," the name given to Europeans who have resided for many years in China. The innate conservatism of the mind of the average Britisher is, as it were, reinforced by long contact with a race that—until very recently—was opposed to change. And so, amongst the older generation of Europeans in the Far East, there are critics who scoff at " the new-fangled ideas " which are changing China. The younger generation of Chinese and Europeans admire the enterprise and courage that was shown by those responsible for the decision that the most magnificent building in Hongkong should be air conditioned. It is my firm conviction that this new building and its modern equipment has greatly added to the prestige of the premier British bank in China.

An " Old China Hand," who visits the bank about once a month, complained that " the air inside is most offensive ; it smells badly and must be unhealthy." After cross-examinations, it transpired that it was the supply of ozone that caused the critic to go so far as to call the inside air " poisonous."

Of course, the explanation that the inside air is far more healthy for humans than outside air was not believed. He was told that the ozone supplied is a disinfectant and kills the germs that might otherwise kill him ! Many people notice the smell caused by the ozone that is supplied to the London tubes. It is not really offensive and the disinfection is well worth any small inconvenience caused by the smell.

This ozone (O_3) is produced by high-tension sparks, etc. The small plant manufacturing it in the bank in Hongkong is placed in the engine-room. About one part of ozone to $2\frac{1}{2}$ million parts of air is supplied.

Unusual difficulties face engineers in the Tropics. The following cause of a breakdown in supply of conditioned air in connection with this plant could hardly have been anticipated. In August, 1936, Hongkong was struck by a typhoon of such force that great damage was done and seventy-eight people were killed. The circulating pumps and motors were flooded with sea water that leaked into the pump house because the abnormal height of the seas in the harbor covered the sea wall. It took some days to repair the pump motors, etc. It was then discovered that many thousands—possibly millions—of shell-fish had developed out of some germ-like sea life, almost too small to be seen, which came in with the typhoon seas into the sump in the pump house. During the normal working of the plant the sea water passes rapidly through the circuit and out again into the sea. The tiny " sea bugs " have then no time to develop into shell-fish in the water circuit. But in a week they became a mass of shells that choked the suction pipe and caused much anxiety and strenuous work. They were also found in the compressor water jackets. It took some time to discover and to eliminate these shell-fish from the circulating water circuit. Precautions against any repetition of this trouble have been taken.

Of course, everyone at work in the building complained when a vital portion of the plant ceased to function for a week. The relative humidity and temperature figures for inside the building were rather better than those for the outside atmosphere, as although the refrigerating plant was out of action, the washers and fan were in operation. At times, when the outside air was at 92 deg. Fah. and 75 R.H., the air inside was kept at 80 deg. Fah. and 82 R.H. by the conditioners. It was lower in temperature and with less moisture in it.

The practical results obtained are of importance. There can be no doubt that, in due course, accumulated data and the experience of engineers in charge of these plants will result in improvements and economies. The engineering profession will, in the meantime, endorse the verdict of the great majority of people in Hongkong, who have visited the bank building and have expressed their admiration for the enterprise of those who decided to install the plant.

Health and Human Efficiency

Occupants of rented offices and the bank employees have informed the writer that they have derived much greater benefits from the new air conditions in the building than they anticipated. The records show far less absence of workers due to sickness. Hongkong doctors agree that air conditioning does improve general health. Amongst the critics who complain are individuals who have passed rapidly in and out of the building. They have experienced the sudden change in temperature on very hot days ; there is some difference of opinion as to whether the inside temperature should at any time be as much as 10 deg. below that of the outside air. The removal of water vapor is much more important than a reduction in temperature.

The human machine is very sensitive to sudden temperature changes. The design of certain cinemas in the U.S.A., in which air conditioning is arranged, permits those entering the main hall to pass to their seats through three or four lounges. So that if the outside air is at 90 deg. Fah. and the inside air is maintained at 75 deg. Fah., the body can adjust its mechanism, gently and more pleasantly, by a less rapid temperature fall than the sudden drop of 15 deg. Fah.

The cost of the plant increases with any increase in the assumed extreme outside air conditions. It is curious to notice that different contractors for these plants in Hongkong have assumed different extreme atmospheric conditions, and in consequence have offered plants of varying capacity for the same contract. It is obvious that if less extreme atmospheric conditions are assumed the cost of the plant will be less. Experience will provide valuable data on this matter.

It is, of course, much more satisfactory to design a building for air-conditioning equipment than to arrange for the plant to be installed in a structure erected without any idea of such an improvement. That fact is mentioned to explain to a correspondent that unless all windows are air-tight and special doors fitted air from outside leaks in rapidly. In my office in the University there was air leakage during tests recorded with the small portable plant, and that explains the excessive quantity of water condensed. A purchaser of one of these small plants complained that it did not cool his room. It was found that he kept the door open to be sure of fresh air ! " You cannot expect a one h.p. machine to cool all Hongkong " was an engineer's comment.

The Results of Experience

There are two outstanding facts about this large installation in the bank building. One is that the occupants of the building are convinced that they have reaped great advantages because of air conditioning. A lawyer in a rented office summed up the contrast between his general state of energy in the old style fan-cooled office and his new style atmosphere in words something like the following : " When I leave my office in the bank at 5 p.m. I don't feel weary. I go straight home. In the old days, in summer, I was fagged out—nervous exhaustion. My first thought was a whiskey and soda in the club to revive me enough to get home. I don't seem to need it nowadays." He said that his general health is much better and that he is able to get through much more work in the bad summer months than under the office atmospheric conditions in former years.

The other fact is that, but for the week out of action due to the typhoon flood, the complicated plant has been working continuously. That is a tribute, not only to the makers of the machinery, but to the resident engineer, who had to overcome unusual difficulties, many of which were unexpected and due to local conditions.

During the whole of 1936 it was not found to be practicable to maintain the desired inside air conditions in the winter without running an NH_3 compressor on light load. The climatic conditions in Hongkong change rapidly ; even in the winter months the humidity is often fairly high. It has been shown by experience that if the water supplied to the conditioners exceeds 52 deg. Fah. the humidity of the air inside the building is too high. When air leaves the conditioner at 52 deg. Fah. it enters the big banking hall at 60 deg. Fah. and 81 R.H.

A most surprising fact is revealed by the color of the fresh water circulated over the evaporators and through the sprayers; it is the amount of dirt removed from the air in circulation within the building. The windows of the building are kept closed. The dirt is due to individuals entering the building with dirty boots, smoking, etc. The fresh air from outside, constantly supplied to the inside, is filtered before entry. It is the air within the building, in circulation through the sprayers, etc. that gives to the fresh water—originally clear—a dirty muddy appearance in quite a short time. It is almost incredible that there is so much dirt in suspension in air within a building. The whole of this water is changed once a month.

The sequel is equally surprising. A pile of paper was left on a desk in an office inside the building for months. There was not a speck of dust on them. The dirt carried into offices in this building on muddy boots, etc., disintegrates and mixes as dust with the air; it is then carried out by the air in circulation and removed in the washers and has no opportunity to settle as dust. That must reduce the cost of cleaning offices, etc.

Tropical Sea Water

There are no fans in offices to make paper-weights essential, as in other buildings where fans only are used to cool the workers. There is no dirt on the furniture in the bank building, for dirt is removed in the air, which is cleaned by the water circulated through the conditioners. That water that cleans the air cools it, and reduces the water vapor content per cubic foot of air. Incidentally, it may be mentioned that fairly constant temperature conditions and dry air reduce the depreciation of furniture, books, and decorations in offices in the tropics.

As far as the writer has been able to ascertain, this air conditioning installation is one of the largest in the world, and is almost certainly the largest for an office building in the British Empire. It is not surprising, therefore, that during the first year of running unexpected difficulties were experienced. For example, the contractors did not expect such rapid corrosion of the steel NH_3 condenser tubes, due to the action of the sea water circulated over them. Some of these tubes failed after about fifteen months, instead of lasting six or seven years, as was anticipated. There seems to be some curious characteristic of Hongkong harbor water which causes rapid corrosion, although all tropical waters increase corrosion. The higher temperature of the water increases corrosion; excessive deterioration has been noticed in connection with steel used in local piers. These condenser tubes corroded very rapidly. Whether any alloy steel tubes would be more economical is a matter that may be worth consideration.

New tubes were necessary and there was some difficulty in obtaining, in Hongkong, those suitable for the purpose. Finally, boiler tubes, not entirely satisfactory for this purpose, obtained from local dockyards, were used as a makeshift. This is mentioned because it is extraordinary that manufacturers in Britain will not realize that conditions in China make it imperative to supply spare gear with any new plant. Nor do contractors always inquire closely enough into the local conditions under which their machinery must work. It is easy in Britain in the event of a breakdown to obtain a replacement from the factory in a few hours. In the Far East it is a very different matter, and therefore ample spares should be supplied.

The majority of British firms, if they wish to share in air conditioning for the tropical buildings, should supply spare gear with their plant. They must remember that the maintenance engineer is far away from the factory and a small breakdown may mean the closing down of the whole plant for days. Local agents for the different parts of the plant should also be able to give technical assistance when unusual difficulties occur.

Time and trouble can be saved if every section of the plant is installed so that the engineer can dismantle it without nearly dismantling the building. It is certain that at some time renewals and repairs must be made, and designers should arrange that they can be carried out as smoothly as possible.

It must be understood that although there are ingenious automatic arrangements, so that stable temperature and humidity conditions may be maintained, the resident engineer must always be watching these to make adjustments. It is a curious fact that various individuals demand varying atmospheric conditions for their comfort; but, of course, these conditions can only be made to vary any one section affected by the one conditioner that treats the air for that section, unless dampers are fitted to vary the velocity—not the quality—of the supply air.

The volume of air required in summer greatly exceeds that required in winter; therefore, in designing the plant the fan motors should be of the variable-speed type. The initial cost will be higher, but a great saving will take place during the winter running.

A notable result of this great experiment has been the general opinion expressed in Hongkong by many business men that all new office buildings will be supplied with air-conditioning plant. It is a fact that the many offices for rent in the bank building were soon occupied, and leading firms in the Colony left out-of-date premises to obtain the more healthy conditions. It was noticeable that amongst the first to move were the members of the American Club, whose premises occupy a large floor area in the bank building.

Local architects estimate that per square foot of floor area, occupants of offices will pay as much as 50 per cent more for premises air conditioned. They also point out that it is possible to be comfortable in offices 13-ft. high, whereas in the older offices in Hongkong the rooms are as much as 16-ft. or 18-ft. high. In the large banking hall the considerations of architectural effect and lighting, etc., compelled loftier heights, but the lower ceilings in small offices increases the floor area of a large building.

These considerations, the saving of fans, cleaning, less depreciation of furniture, and, above all else, the increase in human efficiency due to air conditioning, make its progress in the tropics certain.

There are now a number of these plants of various sizes, many quite small, in Shanghai, Hongkong, and other parts of China. Wherever the effects are experienced, satisfaction and in many cases enthusiasm is expressed by those who receive the benefits of an air-conditioned atmosphere. Engineers are interested, not only in the technicalities of the equipment installed, but in the vista which has been opened up by these mechanical methods for increasing intellectual and physical efficiency of humans working in bad climates. For it is in the tropics that vast natural resources remain undeveloped. In those regions vegetation flourishes to an amazing extent. All sorts of vegetable oils—cassia oil, tung oil, etc.—are exported from the tropics, but their production could be greatly increased. Three rice crops per annum are gathered in certain districts. The conquest of the tropics, their economic development, is now possible because of the researches and practical work of doctors and engineers. The contributions of Sir Leonard Hill, Dr. J. S. Haldane, and Professor A. V. Hill to engineering literature prove that not only engineers, but doctors realize the importance of air conditioning. It is hoped to provide further information on this fascinating subject at some later date. Meantime, it is hoped that British manufacturers will consider the possibilities of this new branch of applied science and the markets awaiting development in the tropics.

Nippon Electric Station in Kurobe Gorge

A large electric power station capable of generating 77,000 kilowatts is being put into operation in the famous Kurobe gorge in Toyama Prefecture, by the Nippon Electric Power Company, Osaka. Work started in May, 1934, and great engineering difficulties had to be surmounted. The company which has paid Y.15,000,000 for the work may now start constructing a third station at Somoya. Incidentally, the largest dam in Japan is the Komaki Dam of the Shogawa Hydro-Electric Power Company, a subsidiary concern of Nippon Power, in Toyama Prefecture. This dam is 1,000-ft. long, 260-ft. high and 216-ft. wide.

Daido Electric Power Company having decided to construct a great reservoir on the upper reaches of the Kiso River in Nagano Prefecture at a cost of Y.13,000,000 has given the building contract to the Hazama Gumi, Tokyo. Work will be started at once, to be completed in 1940. With starting of the reservoir work, sanction will be given by the Communications Ministry to Daido Power for construction of power stations at Kasagi and Nezamenotoko along the same river.

Izumo Electricity Company has asked the Communications Ministry for permission to construct the Hibara power station on the Kiga River in Shimane Prefecture. The station will be capable of generating 6,800 kilowatts of power. The construction cost is Y.2,500,000.

Steel Bridges in the Economy of Railway Construction and Maintenance

Whatever conditions ultimately may develop in China as the outcome of the present conflict, it is a foregone conclusion that the immense recuperative powers of the Chinese will be directed at the earliest possible moment to the vast task of reconstruction and upbuilding that confronts the nation. The great need that has hampered development of the country through all modern times has been adequate railway transportation, and questions having to do with railway building are specially pertinent at this time. The article below and the article that follows it, both by outstanding Chinese engineering writers, will be found of special interest. Both these articles are taken from The Quarterly Review of Chinese Railways.

By C. K. CHIEN, C.E., Rensselaer Polytechnic Institute, Member Commission on Railway Technics

STEEL bridges serve to span rivers and valleys and join the divides of natural obstacles with human creations, thereby eliminating the hazards of river crossings and making travel more speedy, safe, and enjoyable. In the great stretch of man-made permanent ways, winding in and out of the scenic valleys, or laid straight like an arrow in the plains of fertile soil, or crossing the most rugged form of mountainous countrysides, bridges are built to link the chain of transportation making the completion of railroad net work possible.

Indeed, bridges are the links of a chain, for their strength often determines the carrying capacity and limits the running speed of a train on the line. Their construction opens up a great roadway ahead and their destruction puts an end to any direct and speedy access to points beyond. If they are made too strong, they cast a heavy burden on the first cost, and if they are too weak they hinder the growth of traffic that the line could otherwise carry. Economy in the construction and maintenance of steel bridges (for most of the railway bridges are of steel), therefore, deserves due consideration.

In the realm of railway construction, bridgework consumes a large part of the capital layout. Next to rolling-stock and the track, capital expenditures for bridgework rank first in the total cost. For the existing lines of our government, consisting of 7,260 kilometers of main tracks, the following costs appear in our Railway Statistics of 1935:

	Capital Cost	*Cost Per Kilo.*	*Percentage on Total*
Rolling Stock ..	$206,769,625	$26,540	24.8%
Track	$163,692,373	$22,550	29.6%
Bridgework ..	$124,456,797	$17,141	14.9%

For our proposed lines of new construction totaling 2,224 kilometers, the work of which was started in 1936, the estimate for bridge construction alone amounts to $46,983,439. This means a cost of $21,126 per kilometer of line, already an increase over the cost of the existing lines.

But why does bridge construction affect the economy in railway operation and maintenance? Steel bridges are built of suitable materials, types, and designs so as to be as durable and safe, as the capital expenditure will permit. There is economy in keeping the capital cost down to a reasonable minimum, as the traffic will have to bear the interest charge and the annual depreciation. Steel bridges are built strong enough to take care of certain loads, and to withstand the dynamic forces received from the rolling-stock, so as to allow the heaviest engines to operate over them at maximum speed consistent with safety. There is, indeed, economy in handling the largest anticipated volume of traffic in the quickest possible time, as any limitation on train capacity increases the cost of operation. Steel bridges must be so built as to be easily maintained, strengthened and renewed, so that no deterioration due to natural causes may escape attention; no weakening of component parts may take place before the end of their useful life is reached; no difficulty may be encountered in strengthening; nor any necessity may arise for the renewal of the structure at prohibitive costs. There is economy in providing for ease of inspection, ease of strengthening, renovation or repair, as well as for resistance against the elements and other causes of deterioration; since once the structure is open to traffic any suspension, or interruption of service will be very costly. These are questions of paramount importance which a railway bridge engineer has to face when he sets out on the task of designing the bridges for his railway.

Types of Superstructures

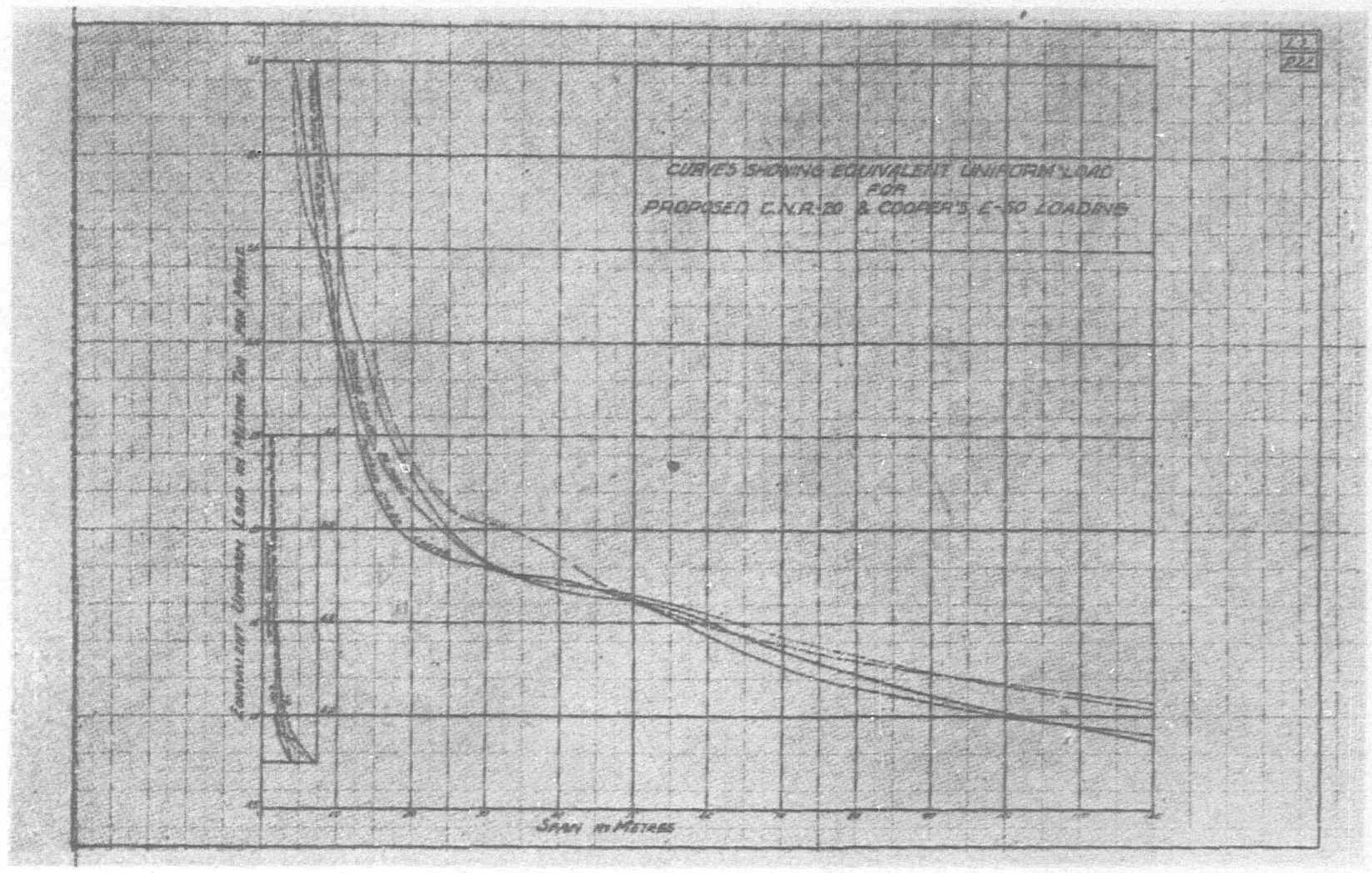
Various types of steel superstructures are used for railroad bridge construction. The proper selection of an economical type depends on the character of the rivers and streams to be crossed, span-length and depth to be chosen, transportation of material and skill of workmanship, anticipated future carrying capacity, ease of maintenance and other factors involved. Where the waterways are wide and shallow, plate girder spans are the preferred type because of their durability, rigidity, capacity for safely carrying overloads, ease of being kept in painting and repairs, and simplicity in construction and erection. The deck type of plate girders, usually requiring no separate floor system, further decreases the length and height of the pier shafts, thus reducing the size of pier bases, and lowering the cost of the sub and superstructures. For deep rivers and more mountainous districts, where longer span-lengths are required to satisfy the conditions of economical design, riveted open-web simple trusses of proper design offer greater economy in construction and maintenance. Pin-connected trusses are not very rigid, easily worn at the pins and pin holes, and, consequently, offer poor economy except for lighter and very long structures. For spans crossing gorges and steep mountains, arches and the cantilever type of construction will prove to be advantageous, but greater cost in the superstructure of these types leads to special problems which we have to consider carefully, since all material for superstructure must be secured from abroad.

The rolled I-beam construction for spans of ten meters or less has all the economic advantages of the plate girder bridges. Although there is a slight waste of material in the web, this can be offset by the cost which is very much lower on account of less work involved in fabrication. Use of this type for longer span-length is, however, not necessarily economical because there is an increase in cost due to higher transportation charges as well as the fact that few mills roll the large sizes required for economic depth. The pony truss or half-through open-web type of superstructure found on our existing lines, built according to European practices, is not a modern economic design. It may appear, to the eyes of mere observers, to offer some security against overturning of trains in case of derailment, but the trusses being connected with shallow cross girders, with no exterior sidebracing, really offer very little rigidity and resistance. A proper design of the bridge floor and the use of guard rails and large guard timbers for the deck type of bridges will usually carry safely across the structure a derailed train provided, of course, that the wheels are not too far out of position laterally to straddle one of the guard rails. Such factors must be taken into consideration in determining an economic type of superstructure.

Economy in Substructures

The substructures supporting the steel superstructures must be economically built, if ultimate economy is to be attained. Conditions of the river-bed, the current, and the nature of the subsoils govern the choice of construction methods and the types of foundation required. While all substructures should preferably be carried down to bed-rock, pile foundations are best adopted for piers in alluvial streams where scour is likely to occur, and the

depth to hard strata is very great. Many of our rivers in northern and eastern China are of this character. In designing we must not forget that pile foundations bear the load entirely by frictional resistance of the piles when the pier base goes down only to the depth of anticipated scour or just a little further. When the base goes so far down that no slightest damage of undermining will occur, then the bearing resistance of the soil may assist the resistance of the pile to carry the load. In construction, if sand or a mixture of sand and a little clay are found, a water jet will overcome any difficulty encountered in driving the piles down such soils.



Coffer-dam construction is best where a hard foundation can be reached at a not very great depth. Certain economic factors must be taken into consideration in adopting this method of construction. Except for very small or unimportant structures, where earth or timber sheet piling may be used for the coffer-dams, steel sheet piling should prove effective in pier sinking in alluvial streams where no serious obstructions underneath are likely to occur. But in such construction, economy and satisfaction can only be attained through the use of sheet piles long enough and properly braced with struts and walings to prevent collapse at the bottom and drowning out at ordinary high water on the top. The steel sheet piles must also be thick enough to penetrate small obstructions and resist injuries to the cutting edges, and they must be provided with suitable caps to stand the pounding of hammers in driving. Unless such precautions are taken, the advantages of using the sheet piles over and over again are soon lost.

The method of open dredging for pier construction is suitable in deep foundations where bed rock is not to be reached and where pile foundations are inadmissible. Its use, as against that of the pneumatic process, is again largely dependent on cost as the pneumatic method of sinking piers requires an expensive plant and very skilled laborers. When pumping can be successfully done, the cost of excavation is in favor of open dredging. Where difficulty is liable to be encountered in open excavation, such as hard pans or bed rock or large boulders, the pneumatic caisson is the only suitable method. There is, however, a limit as to the depth of sinking pneumatic piers ; for greater depth, open dredging must be resorted to.

For the construction of substructures a complete boring record of the soils in the river bed before designing and a knowledge of the nature of the stream flow are very necessary. Experience and alertness in meeting whatever contingencies arise, will result in a successful job. Many engineers falter because of their hastiness in deciding the method of construction, their failure to take proper boring records, and inability to anticipate difficulties which otherwise could have been provided for and solved. There is no economy in rushing a job without due preparation for meeting all possible contingencies.

Proportion of Spans and Depths

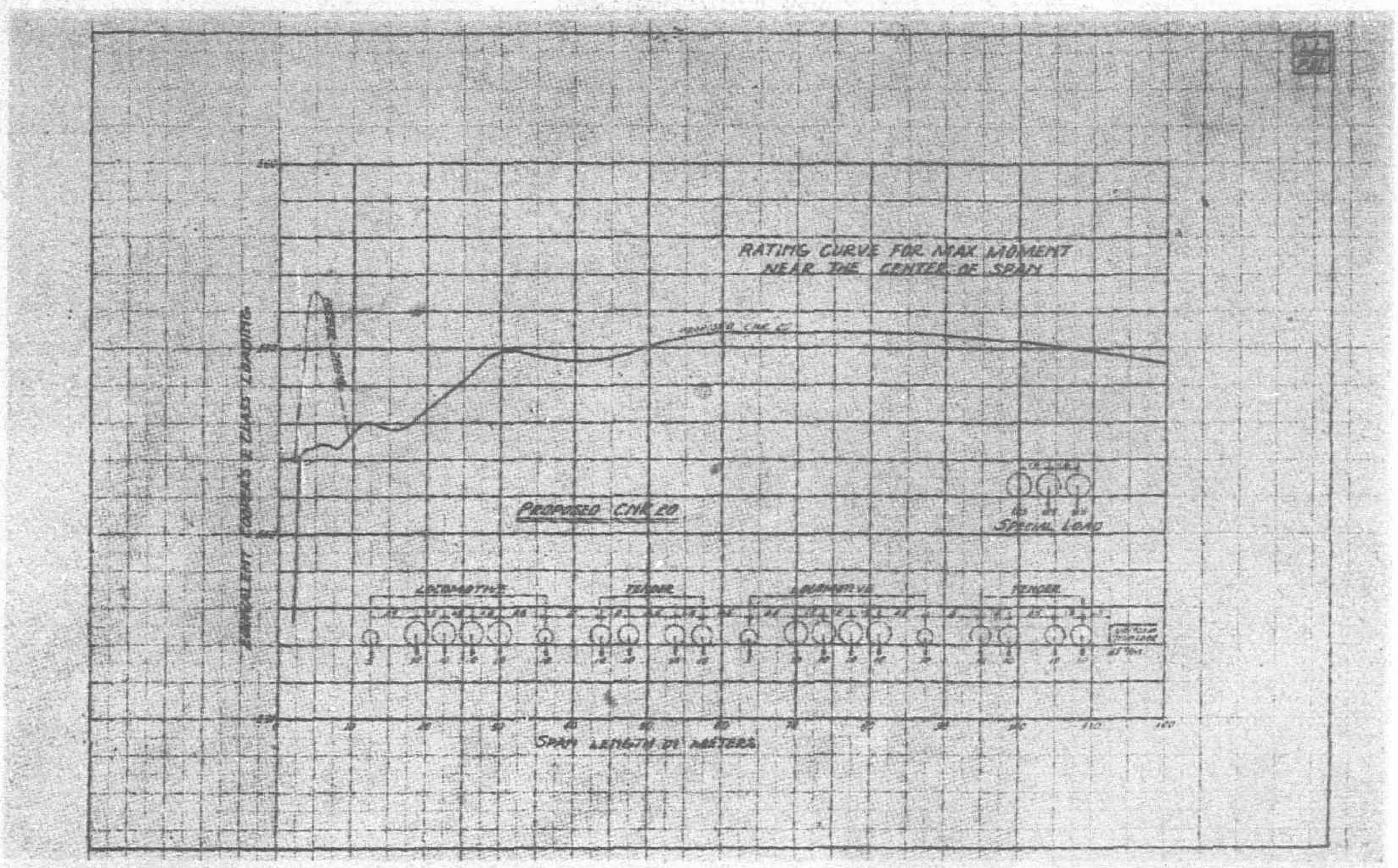
A proper choice of the type of superstructure and substructure depends on the characteristics of the streams and rivers to be crossed ; but how can economy in design be achieved after conditions in the field are satisfied ? In order to solve this, engineers have spent considerable time and energy in investigation. Depth and span of the superstructure are undoubtedly the basic variables that determine the weight of material. It is necessary in designing, therefore, to adopt some economical depth and span. Theoretically, in a parallel chord truss the greatest economy of material will prevail when the weight of chords is equal to the weight of the web, and in a plate girder bridge or the floor system of a truss bridge the economic proportion of weights should be to make the weight of the flanges equal to the weight of the web and its detail. By varying the depth, the designer will be able to meet these economic conditions.

An old criterion for the economic span length is to make the cost of a pier equal to the cost of the span which it supports. Dr. Waddell in his treatises on economics of bridgework modified the criterion by stating that the greatest economy will be attained when the cost per lineal foot of the substructure is equal to the cost per lineal foot of the trusses and lateral system. As floor systems do not usually vary much with the difference in span length, Dr. Waddell's principle should be the more accurate one. The designing engineers, however, usually find it difficult to make a true estimate of the cost of the substructures which, in designing, are yet to be built. The " per pound " value of structural steel in manufacturing countries is ordinarily fixed, and so the cost of the superstructure can be more easily estimated. When we have to depend on foreign supply, the cost again becomes uncertain.

While economic depths should be observed, special conditions may require shallower ones. There is an economic limit as to the cost of web plates, or an economic proportion of depth of trusses to reduce reversal effect of wind stresses on chord members. Economic span length may have to be sacrificed, since materials for superstructures are not yet being furnished by ourselves. Greater spans will require more steel to be purchased from abroad. One, however, cannot be too specific, and yet when designing the structure, should not forget the true foundation for economy. For only by strict observance of economic engineering principles, can railroads be built, operated and maintained on a sound basis.

Bridge Capacity, Present and Future

To the design of a bridge to meet the economical requirements of a railroad then comes the question of the expected capacity of the bridge which is expressed in terms of a system of rolling loads. Different countries have adopted different standard systems to meet the conditions of their rolling stock and traffic. The American standard is a conventional system called Cooper's Loading, consisting of two locomotives of 2-8-0 type and tenders followed by a uniform train load. The weight on the driving axles determines the class, which in America has grown during the last 25 years from 40,000 to 72,000 pounds per axle, commonly known as E40 to E72. Our railroads, before the promulgation of the various engineering standards in 1922, had no definite specifications, using whatever the engineers thought fit. But after the promulgation, Cooper's loading classes E50 and E35 were adopted respectively for trunk and secondary lines. The question of the adequacy of these loadings for our railroads can be logically determined only by an exhaustive study of the traffic conditions existing, and the locomotives used on our roads, as well as by a comprehensive forecast of future traffic to be carried, and changes in locomotive construction expected. Such study and forecast must cover the full period of useful life of the structure, for true economy is not to overburden the traffic with heavy structures, meaning dormant investment in the first cost for a long period of years, nor



maintenance of our railroads. Modern tendency in economic transportation is to increase speed. This has caused the Consolidation type of locomotive, adopted by Cooper's loading, to be inefficient in handling such transportation. A system of rolling loads for better locomotive design to give as nearly an equivalent to the Cooper's loading as possible is, therefore, advocated. The new system proposed consists of two locomotives of the 2-8-2 type commonly known as the Mikado engine, and tenders to be followed by a uniform train load. The axle loads and spacings are so chosen to give as nearly as an E50 loading as possible. For trunk and principal lines, axle loads of the driving wheels will be 20 metric tons each, so that the system will be known as CNR 20.

As most of our existing roads and new lines to be constructed are trunk lines, one system will help toward standardization. But since many of the new lines are going through less developed and mountainous countries, and only limited funds are at our disposal for new construction, a secondary loading is still deemed advisable. In order that the basic economic principle is not too much sacrificed, this secondary loading is made up with driver axle loads of 16 metric tons each, to be known as CNR 16, resulting in a slight increase over the old E35 type, but it is believed that a more economical future is taken care of.

to limit traffic with light structures so that replacements are too soon found necessary An excessive first cost in bridges in connection with railroad construction often means so great a financial requirement as may eventually cause the abandonment of the whole construction project. This means the selection of not too heavy a loading for the construction of new lines. The trend of modern railroad transportation is, however, toward greater train capacity and faster speed. This must also be coped with, for economy is the essence of railroad industry, and if speed and capacity can produce economy, the bridges should not hinder its development.

The selection of the loadings for our railway structure could be much simplified if our locomotives were standardized. Standard axle loads and spacings, uniform dynamic effects, and economic operating speed which determine the stresses in our bridges, could then be our definite guides. With the existing condition of our rolling stocks, in which out of an approximate number of fifteen hundred locomotives in service more than thirty different types are found, and the ratings range from several antiquated E10 to a number of Mallet engines of the E50 class, a selection would be very difficult. Modern locomotives, however, are built to develop maximum power for the least given weight. An economical locomotive would then be one which performs the maximum work with a minimum consumption of fuel, while producing the least amount of stresses in the tracks and bridges at a given operating speed. Such evolution of locomotive construction and the demand for improvement give us plenty of thought for consideration.

The fact that properly built bridges have been maintained carefully in service on existing railroads to carry safely loads much in excess of the loading designed for, has led the American engineers to make certain studies and therefore, provisions in the design-specifications for new construction. This means the designing of the bridge for the present adopted loading at a normal allowable working unit stress of the steel. After the structure has been designed on this basis, it is then checked for an increased live loading to a certain higher allowable unit tensile stress of the steel, so that the component members of the bridge will not reach that increased live load at the higher allowable unit stress sooner than the others. This develops the overstress capacity of the bridge to the fullest extent as there will be no member showing an early limitation to the increase in capacity. Upon these principles, we are adopting bridge loadings economic to our present traffic conditions, suitable to our available finances, and covering the expected future increase in traffic.

New Chinese National Railway Bridge Loadings

A further study of the locomotives on our railroads leads to two vital evolutions already under way. They are standard locomotives and bridge loadings of our own, the result of the pressing demand for more economic construction, operation and

Grade of Steel

Having ascertained that types, spans, and loadings are the most economical selected in the design of the bridges, one must turn to the quality of material and, therefore, the permissible stresses used in our economic design. Elementally, steel is an alloy of iron and carbon ; its adaptability, workability and cost, which determine the choice, could be made to vary with different conditions of our requirements. A higher quality of steel permits higher unit stresses, which help to reduce the total weight of the structure ; but higher ultimate stresses are usually accompanied by lesser ductility, a factor which the user of soft mild steel advocates. The modern steel industry produces a medium quality of steel at only a slight cost above the soft product, while high tensile steels are now used in practically all large structures. Modern machine tools also are made to work the higher quality steel, so there will be no difficulty in fabricating the structure. There is economy, then, in the proper selection of the grade of steel.

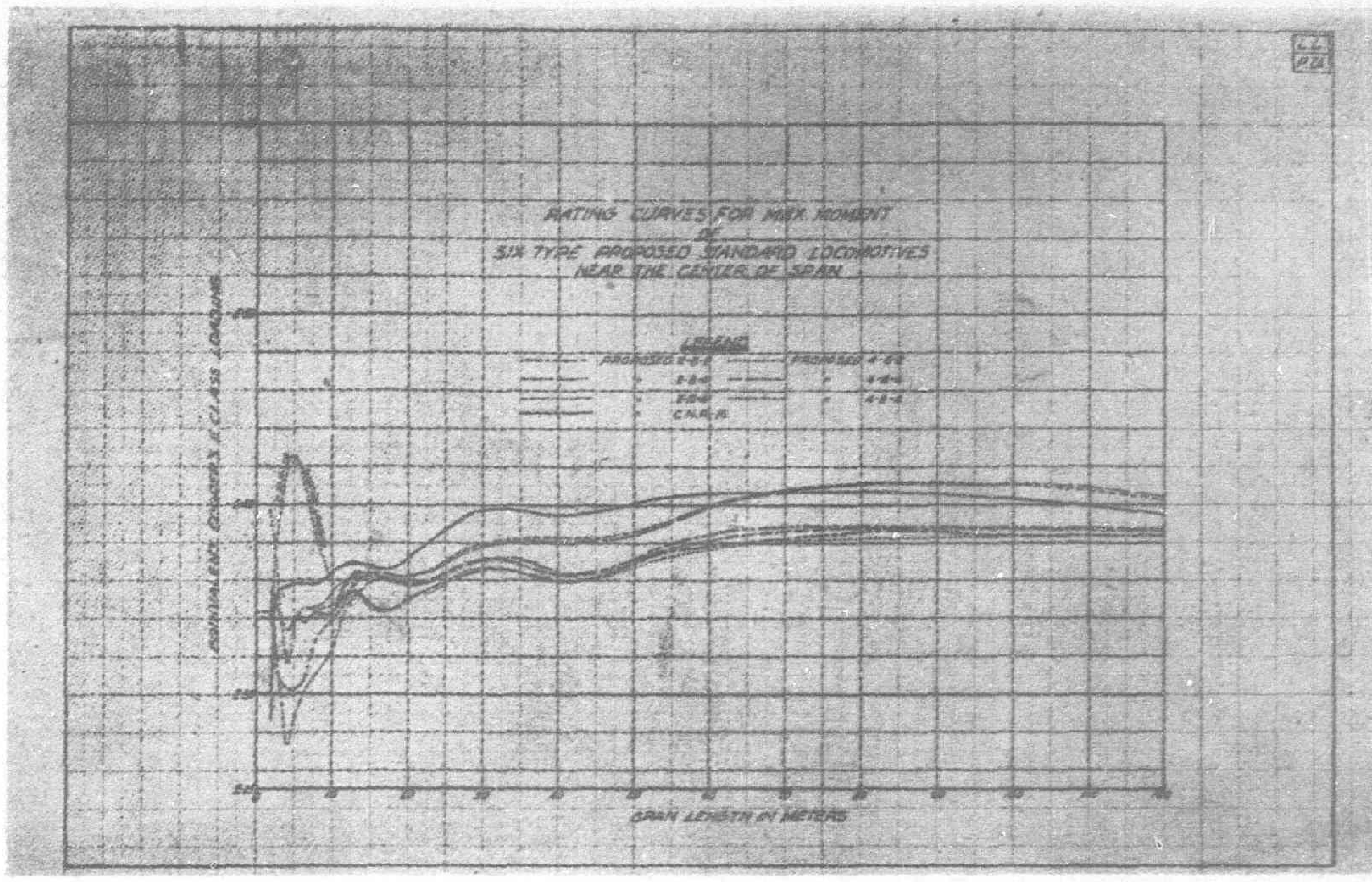
Reliability, which is synonymous with safety, has heretofore been the most important argument in using steel of a softer grade. Reliability must again be our reason for selecting the higher grade of steel, consistent with economy. The present adoption of steel of 42 to 50 kilograms per square millimeter quality for our bridge specification enables us to keep pace with modern progress and take due advantage of developments in the world's steel industry.

Unit Stresses and Factor of Safety

Problems in regard to the physical and chemical properties of steel can readily be solved if the manufacture of steel is a native industry. Since we have to secure this material almost entirely from abroad, different origins will still give us different products although they may pass the same tests in our specification. We must be conservative in adopting the allowable unit stresses. Theoretically, structural steel may be stressed up to the yield point without weakening. But in permitting stresses to that point, all conditions of loads, ageing, and other imperfections must be taken into consideration. In no other branch of civil engineering can it be said that the laws of stresses are more definitely determined than in this branch ; so when stresses are permitted in structural steel, a most economical value is set, but we must not stretch that value so that economy is obtained at the sacrifice of safety.

The factor of safety is very easily misunderstood when one merely considers that, for a minimum yield point of 23 kilograms

per square millimeter in steel of medium quality, the allowable unit stress is only 12.5 kilograms per square millimeter. This margin may appear to the layman as large, but an engineer turns quickly to add wind stresses, temperature stresses, and secondary stresses, as well as to provide for deterioration, imperfect workmanship, overruns in loads and many other factors. When he is through, there is usually very little left, and this is again reserved in current designs to permit future over loading.



Standardization and Economic Benefits

Economic designs made by engineers in the office should always be accompanied by skill and efficiency in the shop and in the field. In reducing the minimum yield point, designers must bear in mind the question : will the cost of labor be unduly increased ? In selecting lengths, sizes, and thickness, will it not exceed the practical limits or fall under the minimum allowable ? In choosing many varied sizes, will it not cause more labor in set-ups or require more tools ? A machine when it is set up for certain standard work over and over again, or a template made for a large number of the same details, will always reduce cost and eliminate waste. Standardizing in design and details will offer many economic advantages.

Had our railroads maintained a large bridge shop to fabricate steel bridges, standardization would have long been strictly adhered to, for it is easier for the shop man to realize economy in such a policy. With a centralized designing office, standardization would also be easier to carry out. But if the designing of bridges is to be left to every individual line and their individual engineers, or if steel of all makes and the products of different countries are indiscriminately used, standardization will become difficult of relization.

Whatever economic benefit can be derived from standardizing bridge construction, it is the same for all other railroad problems. Standardization reduces the work of calculation, design and attending to all the details. It enables the field engineer to know the weight of certain spans, types and loadings so that by fitting in the spans to the profile of the river bed and with the aid of proper boring records, a most economic layout for the crossing may be estimated. The purchaser, knowing the standard required, can make a quick order. The shops turn out their standard details template and fill the order in quick time, and therefore, at the least cost. The construction engineer is familiar with the assembling and erection of the structure, and the workmen trained to handle that work with ease and confidence. The operating department, knowing the nature of the structures on all the lines, may operate their trains with safety, full capacity, and speed. The maintenance department may keep standard parts, for in the absence of any standards, it would be too prohibitive to produce the required parts. In case of destruction, a replacement can be easily made, while care and up-keep can also be systematized to reduce administrative costs.

Engineers are beginning to realize the importance of standardization. In the early days, they were confronted with difficulties. Our first railroads were built largely from foreign loans, British, French, Belgian, German, etc. These loans brought with them materials, engineers and engineering practices. Later, many of our returned students brought back with them American practices acquired in America. In truth, there is so much for us to learn from the ways of others, that it is difficult to choose a suitable standard.

Internal strife, so frequent in years past, has not permitted a steady growth of our railroads. For standardization, it requires steady and uninterrupted efforts which can only be realized in normal times and by strict adherence to basic principles. The variety of structures already found on our railroads could not therefore be easily replaced or eliminated. Nevertheless our engineers are conscious of the importance of standardization in the interests of economy. For new lines recently completed, such as the Chu-Shao section of the Canton-Hankow Railway and the western section of the Lunghai Railway, a uniform standard of E50 loading has been adopted. The same standard is used for the replacement of bridges on the Kiaochow-Tsinan Railway. In the meantime, however, economics in engineering have made further progress, so that better and more economic methods are possible. Bridge loading and specifications, therefore, are likely to be revised. It is hoped that, after revision, standardization will be carried out a step further for the sake of greater economy.

New Construction

In the National Government's program of railway construction to facilitate communication with our interior provinces, bridge engineers have been called upon to contribute their share in making the projects economically successful. The new lines will have to pass through rugged and mountainous terrains. Bridge engineers may well keep in mind that the track gang and the work train will be waiting for the first spans to be set in place for them to proceed onward. To connect the existing lines, railroad authorities are watching anxiously the completion of bridges, such as those over the Chientang and Tsao-ngo Rivers. With the recent completion of the Canton-Hankow Railway, direct transportation from Canton to Peiping, or even to Hamburg, Germany, is possible following the completion of the Wu-Han bridge at Hankow to span the mighty Yangtze. But all the task before us involves economic considerations. The only sound solution would seem to be to bring the first cost down to a wise and economic level, to operate the line at a minimum expenditure, and to maintain the structures throughout their life of usefulness. The rôle to be played by the bridge engineers is a very significant one—being a vital link in the long chain of economic planning.

Korean Developments

A policy for development of Mozan Iron Mine in Korea has been agreed upon by the Tokyo Commerce and Industry Ministry and the Korean Government-General. The Ministry undertakes to persuade Mitsubishi Mining Company, which will build blast furnaces at Seishin, to co-operate with the Government-General in the development of North Korea. The Government-General is to build a railway from Mozan to Komozan and reconstruct Seishin harbor. Construction of a large coal liquefaction plant on the Korea-Manchoukuo border has been tentatively decided on as a result of discussions between authorities of the Manchoukuo Government, the Korean Government-General and the South Manchuria Railway Company. The projected company will be capitalized at Y.300,000,000. Capacity of the plant is to be about 400,000 metric tons a year. The Company will install water power generation equipment on the Yalu and Tumen rivers.

Rolling Stock in the Economy of Railway Transportation

By Z. Z. ING, Mechanical Engineer, Commission on Railway Technics

In the field of railway transportation, rolling stock forms the essence which actually performs the act of conveying passengers or goods from one point to another. The economy of its operation and maintenance casts a direct reflection upon the overall cost of transportation. To reduce the cost of transportation to the minimum, it is, therefore, necessary to get the most out of the rolling stock with the least amount of expenditure. Although the overall cost of transportation may be reduced by increasing the amount of traffic, thereby obtaining a general reduction of fixed charges by distributing them over a large amount of traffic handled, the effect of such reduction is quite insignificant when compared with the direct reduction which can be obtained from the economic operation and maintenance of rolling stock and which is independent of the amount of traffic handled. To achieve economy through the efficient operation and economical maintenance of rolling stocks requires a careful study into the science of rolling-stock designs, as well as their proper operation, care, and maintenance, with due consideration to tracks, bridges, and other permanent structures on the lines upon which the stocks are to run. Hence, true economy begins with the design of rolling stocks, and is brought out by their proper use and care, kept up by timely maintenance, and revived through their economical repairs.

Correct Locomotive Proportions, the Source of Economy

Our first attention naturally is turned to the locomotives which furnish the motive power for the railway transportation, and which may be considered as the head of the " wage earners " in the family of rolling stocks. Fundamentally a locomotive is a power plant on wheels, forming a system of rolling loads which produce stresses and strains to tracks and bridges as it runs over them. For the sake of safety, with a given set of track conditions, the maximum total weight of a given system of rolling loads is limited so as not to overstress the tracks and bridges. This limitation of weight imposes a corresponding limitation to the capacity of the locomotive. Hence, to secure the maximum economy, a locomotive should be designed to give the maximum capacity for a given set of track conditions, for it is neither economical nor efficient to run a number of light trains to congest the traffic with increased wear and tear, and it is certainly dangerous and unsafe to operate heavy locomotives to overstress the tracks and bridges. Many locomotive builders, on the other hand, in order to simplify their problem, are in the habit of designing locomotives to suit a specific traffic requirement for a specified maximum axle load, and students in locomotive designing are taught to do the same. The result of such a design is an unsuitable locomotive, either too heavy for the tracks and bridges, or too light for economical transportation.

The capacity of a locomotive referred to above, includes the starting effort, which is solely governed by the adhesive weight on the driving wheels, as well as the capability of a locomotive to handle a train of certain weight at a speed, which is determined by the maximum horse-power that can be built into a locomotive of a given weight. Principally our locomotives are steam power plants, each consisting of a boiler and an engine of two or more cylinders, the energy from the steam generated in the boiler being conveyed to the cylinders and thence through the driving wheels to the drawbar. For a given boiler pressure, the starting effort is, therefore, a function of the cylinder dimensions and driving wheels diameter while the power output is a function of the rate of work done by the steam in the cylinders, which is measured by a function of the cylinder dimensions and the speed which the driving wheel makes. For a given size of cylinders and a given valve gear characteristic, the maximum power output of a locomotive can be obtained only at a definite speed. If that speed happens to be the average operating speed of the locomotive, it will, consequently, develop its maximum power most of the time with the least amount of steam consumption. Hence, for economical transportation, the locomotive cylinders and driving wheel diameter should be so proportioned as to give the optimum power at a given operating speed with a minimum amount of steam consumption. However, to simplify matters again, most of locomotive builders prefer to proportion the cylinder size and driving wheel diameter of a locomotive in accordance with the adhesive weight on the driving wheels or for economical steam consumption. The former proportion results in an engine with high fuel consumption whereas the latter method results in oversized cylinders, carrying unnecessary dead weight with increased resistance, so that whatever economy may be derived from the design is more than offset by the power required to overcome the resistance due to the excess weight.

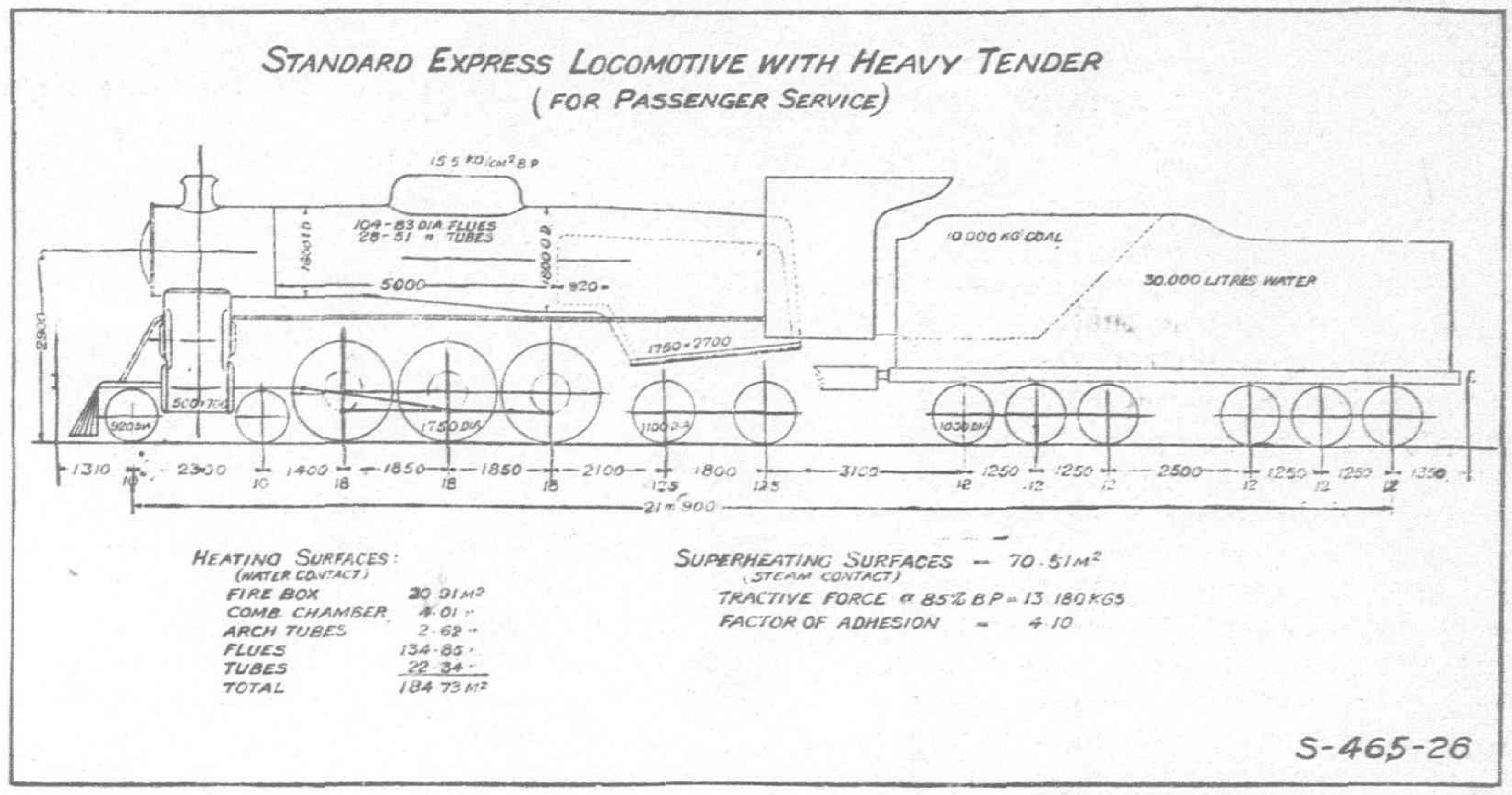
But the cylinders cannot develop any more power than that which can be supplied from the boiler. As the entire power plant is limited by the permissible weight for a given system of rolling loads, it becomes apparent that the boiler be designed to generate a maximum amount of steam for a given weight. This may be accomplished by either providing a maximum amount of heating surfaces for a given weight or by increasing the heat absorbing capacity of each unit of heating surfaces ; and, by combining the two together, it is not difficult to get the maximum evaporation from a boiler of a given weight.

The above is a brief analysis of the proper method to be followed in the proportioning of the principal parts of a locomotive for efficient and economical transportation. This method is a distinct departure from the conventional methods of locomotive designing, using the meaningless empirical formulæ, applicable to only a handful of certain types of locomotives within a very limited range of operation. This method is based upon the application of the fundamentals of steam power plant engineering to the design of a locomotive subject to certain restrictions as determined by its system of rolling loads and is, consequently, applicable to all coal burning steam locomotives. The use of this method results in an economical locomotive with a maximum power for a given weight, that is, a minimum of weight per horse-power, with a correspondingly low water rate.

Locomotives built according to the conventional methods of designing weigh about 65 kg. per indicated drawbar horse-power with a water rate of about 7.5 kg. per horse-power per hour, whereas with this improved method of locomotive designing, employing the fundamentals of steam engineering, this weight can be appreciably reduced with a corresponding reduction in the water rate. The four 0-8-0 locomotives of the Yueh-Han Railway weigh only 50.8 kg. per indicated drawbar horse-power with a water rate of 6.20 kg. per horse-power per hour, and the 24 4-8-4 locomotives of the same railway weigh also 50.8 kg. to an indicated drawbar horse-power with a water rate of 6.19 kg. per horse-power per hour. Both of the two types of locomotives were conceived, developed, and designed by the writer with this improved method of locomotive designing and were built under his personal supervision by the British builders. The weights of the 4-8-4 locomotives could have been further reduced without sacrifice to the power of the locomotive or the strength of their details, had the writer's recommendations been fully carried out.

Reduced Capital Outlay with Increased Availability

Although proper proportioning of the principal parts of a locomotive is of prime importance to economical transportation, the effect of such economy cannot be realized without the support from the proper design of the details which not only affect directly the finished weight of a locomotive but also its operating and maintenance cost as well. For this reason, all details should be designed to give a maximum availability of the locomotive with a minimum weight, but with no sacrifice in strength, and these details should be so located as to give a maximum of accessibility for inspection, lubrication, and/or repair. A locomotive to be an asset to economical transportation must be able to be kept on the road with the least amount of attention and must be free from liability to breakdown and failure under normal operating conditions, otherwise it becomes a burden to the railway, because, for each day it is kept off the road, another locomotive is required to take its



place, thereby increasing the capital investment for another locomotive, in addition to the interest on the capital invested on the locomotive plus the repair cost, both of which are directly chargeable to the locomotive.

The free and easy access to various parts of a locomotive is equally essential for the economical operation and maintenance of a locomotive. Parts that are inaccessible will have less chance of being properly looked after and cared for. Even locations of details such as cab fittings, gauges, operating levers, etc., should be carefully planned if lost motions are to be eliminated to facilitate the operation of the locomotive by the engine crew, and to increase safety on the road by directing the crew's attention to the road instead of looking all around in search of the levers, gauges, and/or other details required for the proper functioning of the locomotive.

Some locomotive builders in their anxiety to secure orders, are used to undercutting prices by furnishing locomotives with details "skimped" down to such a point where no consideration can be given to either the availability or the accessibility, and replacing materials of inferior quality in order to cut down their cost of manufacturing. We, as railway owners, in our anxiety to cut our cost, have, as a rule, accepted such low priced locomotives, thinking that we are really getting a bargain, until the locomotives have to be laid up in the sheds every now and then, thereby becoming a burden to the railway instead of a "wage earner." To a great extent, such practice may be averted and avoided by rigid specification and thorough inspection, but our specification writers have been handicapped with rules and orders not to be too specific as to intimate favoritism, thus leaving plenty of loopholes for the builders to take advantage of; and inspection cannot improve either quality or workmanship, if the builders have the intention of "putting something over."

Light-Weight Car Design Makes Room for "Pay" Load

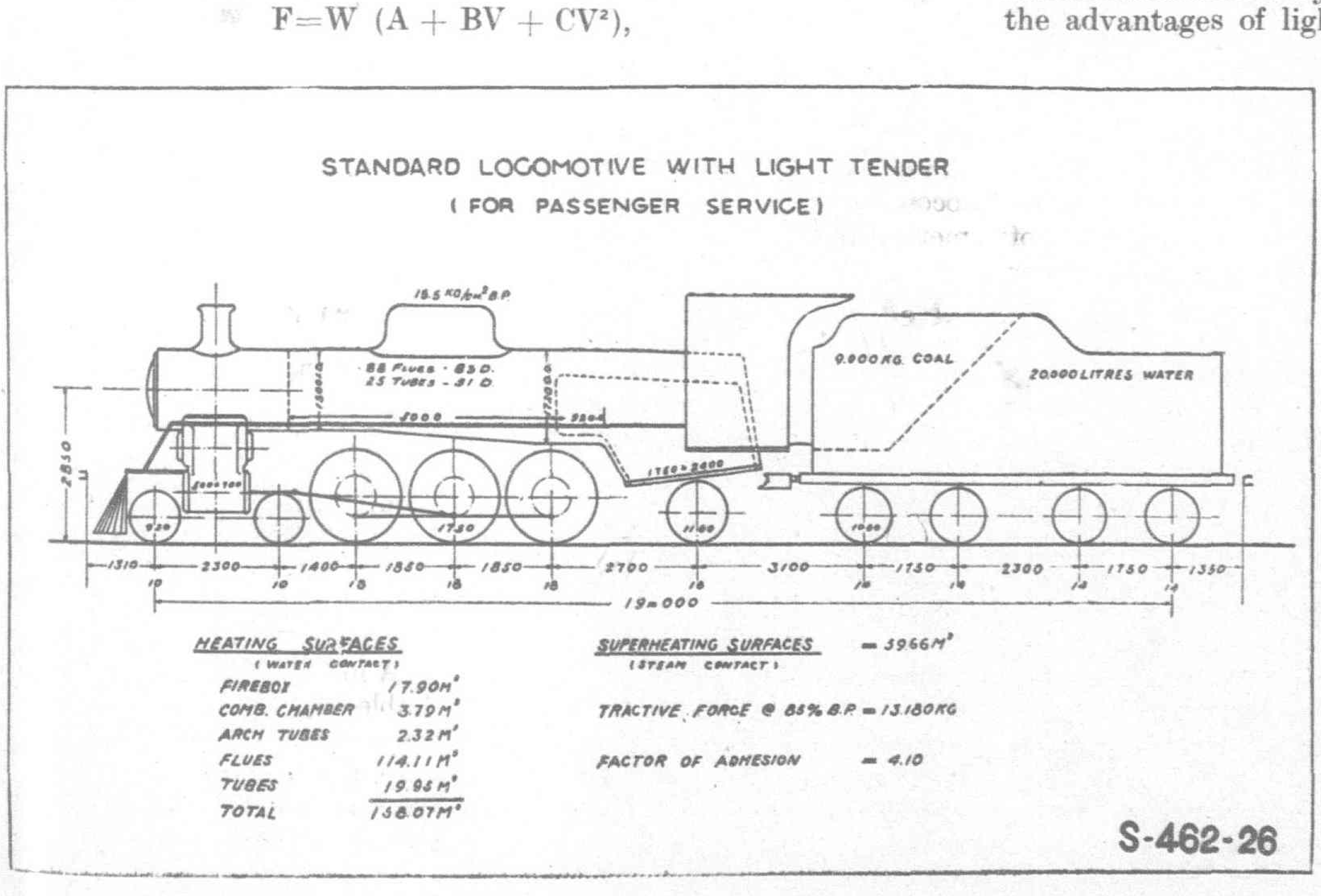
The fundamental principle as applied to the design of locomotives is also applicable to the design of carriages and wagons. The designer should aim to provide a maximum of accommodation with a minimum of weight, for the customer pays for the actual weight hauled and the railways pay for the dead weight. When a locomotive is hauling a train, it is really performing an act of "balancing" its available tractive effort against the resistance of the train, which may be generally represented by the equation:

$$F = W\ (A + BV + CV^2),$$

in which F represents the available tractive force; W, the weight of the train; and V, the speed; A, B and C being constants for the type of cars in the make-up of the train. From the above equation, it is evident that a reduction in the weight of each car in the train, will result, for the same tractive force, in an increase in the number of cars in the train of a given weight or in an increase in speed. In either case, the gain derived therefrom means a direct increase of revenue for the operating railways with the same consumption of fuel.

One way to achieve weight reduction in car designing is the light-weight construction using the ordinary carbon steel with stresses properly distributed over all the members in the car body, and the extensive application of welding will make possible a further reduction. The "new" third class "blue steel" coaches of the Tientsin-Pukow Railway placed in service about four years ago, were designed according to this method, resulting in a reduction of about 10 tonnes per car over the old "blue steel" coaches which were designed and constructed in accordance with the conventional method, weighing about 55 tonnes each. As the weight is taken off entirely from the car body, this reduction represents a saving of 25 per cent over the old method of designing. The new steel coaches recently placed in service on the Yueh-Han Railway were designed and constructed in accordance with this light-weight principle, showing the confidence of railway engineers in such a design as being safe and sound.

Weight can be further reduced by the use of high tensile light alloys, and it is quite possible to take off another 25 per cent to 30 per cent with these special materials. Although the prices for such materials are very much higher than the ordinary carbon steel, the advantages of light weight in the form of increased revenue and the reduced maintenance cost will more than offset the initial capital outlay. The modern high-speed "Streamlined" trains are examples of the practicability and feasibility of these light weight cars. The cost of operation and maintenance on these cars is just about half that of the old cars of conventional type built with carbon steel. Even wagons can now be designed and built in accordance with the light-weight principle with similar advantages.

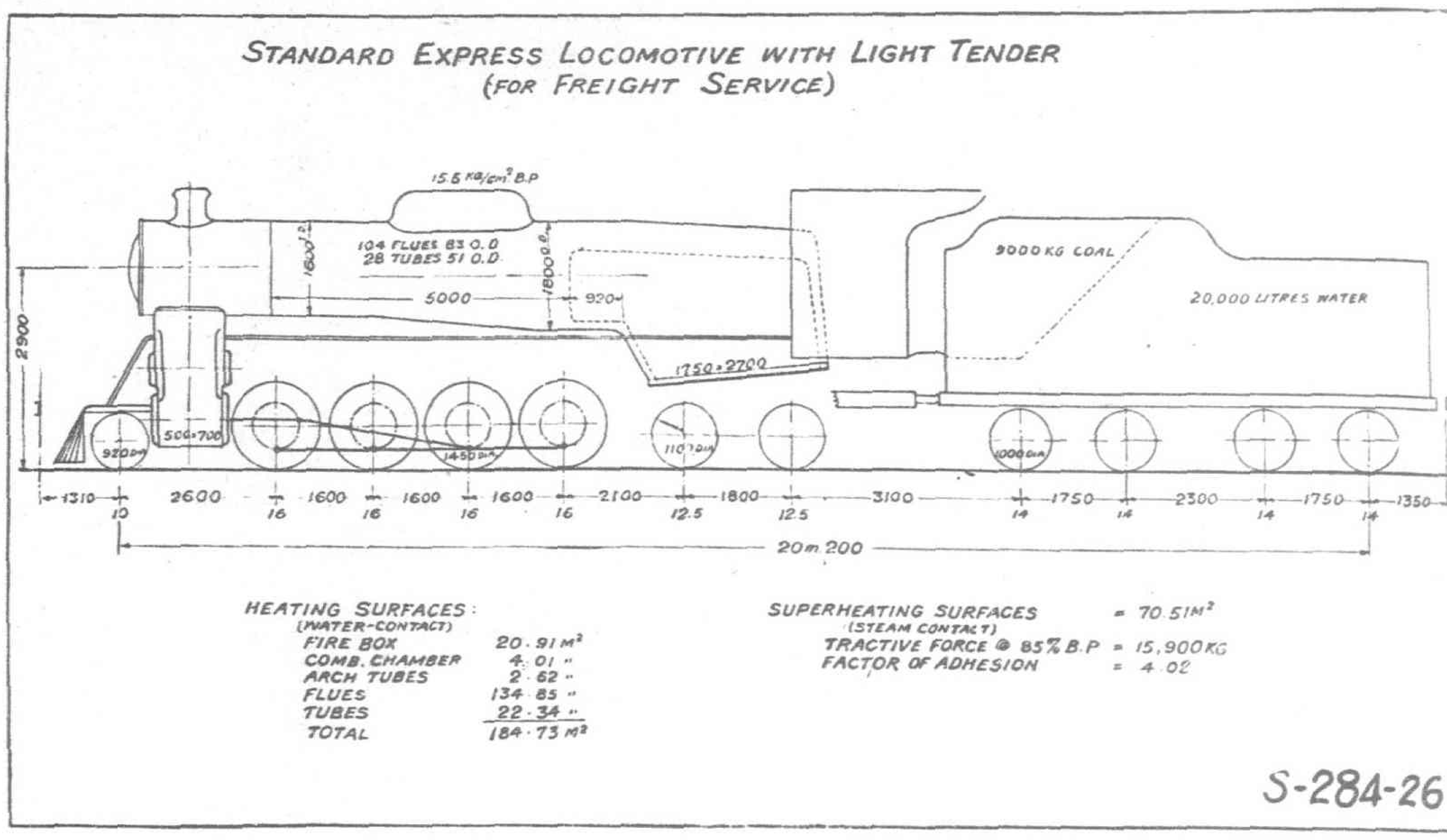


Decreasing Car "Resistance Factor" to Increase Earning Capacity

A study into the equation given above, will reveal another method of increasing the earning capacity of rolling stocks, by reducing the factor $(A + BV + CV^2)$ in which A represents a fixed constant not affected by speed, BV represents some kind of resistances that vary directly as the speed, and CV^2 some other form of resistances that vary as the

square of the speed. Considerable amount of study in conjunction with dynamometer car tests is required in order to determine how this resistance factor can be reduced. The application of roller bearings, streamlining, and the design of articulated units are some of the examples that effect an appreciable reduction in the value of this factor.

In the endeavor to reduce car weight and the resistance factor, it is very important that strength and safety must not be sacrificed. In the design of passenger cars, comfort to the riding public must not be overlooked and, for the freight cars, provision should be made to protect lading from damage during transit. Naturally, consideration should also be given to availability and accessibility as well as to obtain safe, trouble-free and economical transportation.



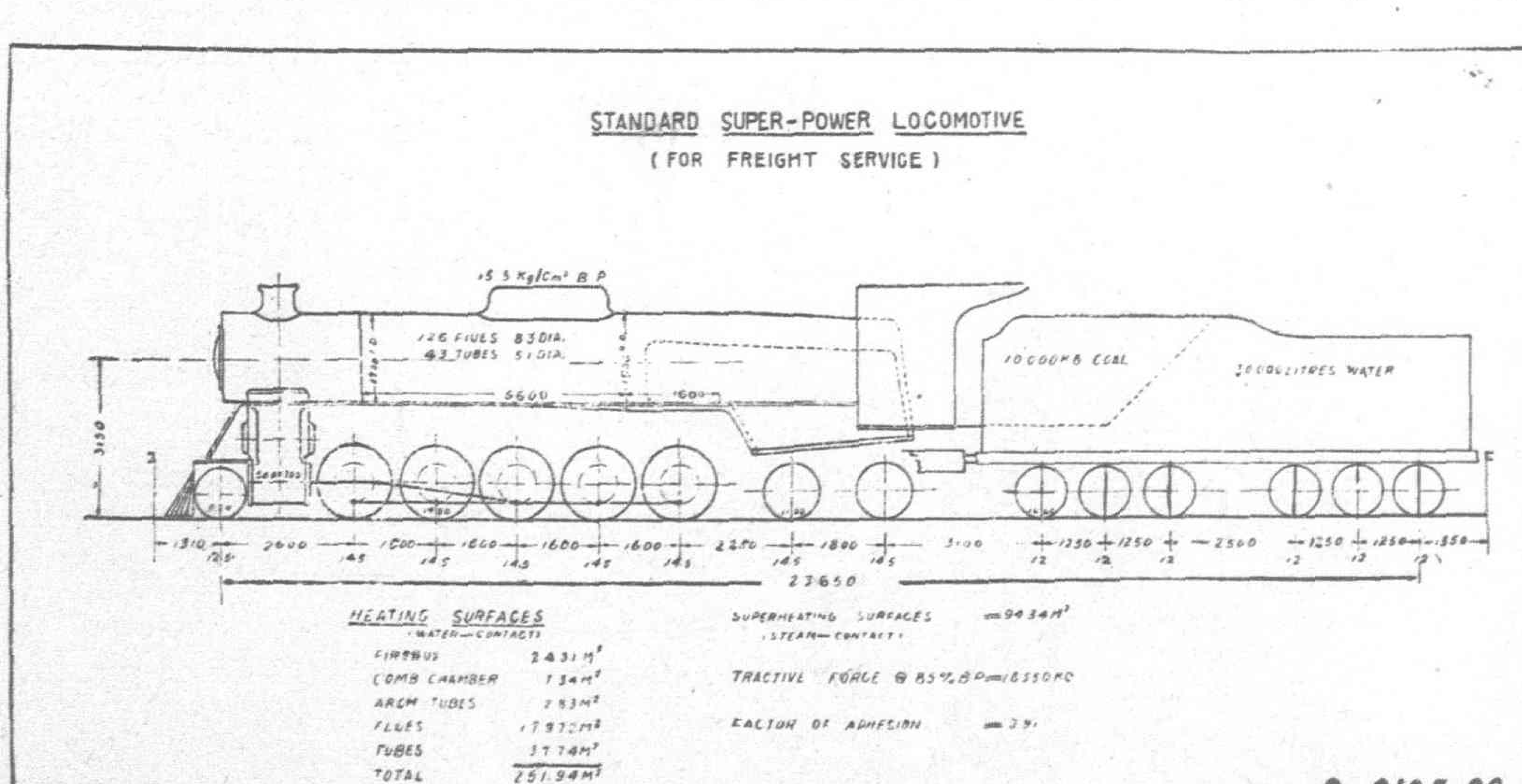
Economy Achieved Through Efficient Operation, Care, and Maintenance

Excellence of design and perfection in workmanship can only create economy in the rolling stocks, but without proper operation, vigilant care, and timely maintenance, this economy will remain dormant. No machine can be satisfactorily operated under varying load conditions without proper manipulation from an intelligent operator, and a locomotive requires even more than common intelligence for its proper operation in order to realize the power and economy that are designed and built into it. The engine driver must have a thorough understanding of the functions of the various levers under his control and co-ordinate his manipulation of these levers with the indications shown on the various gauges. The principal duty of an engine driver is to make each kilogramme of steam do more work so that the fireman can do less work to keep up the boiler pressure, thereby reducing the amount of coal fired for the same output. But our drivers prefer to " crack the throttle " and use long out-offs, resulting in high velocity of steam through small throttle valve openings, wearing out the valve stems by the abrasive action of steam under high velocity, and reducing the steam pressure before reaching the cylinders. As a result of such operation not only the haulage capacity of the locomotive is greatly reduced, but also the fuel consumption is highly increased and the cost of maintenance is correspondingly enhanced due to the premature wear and tear resulting from improper operation.

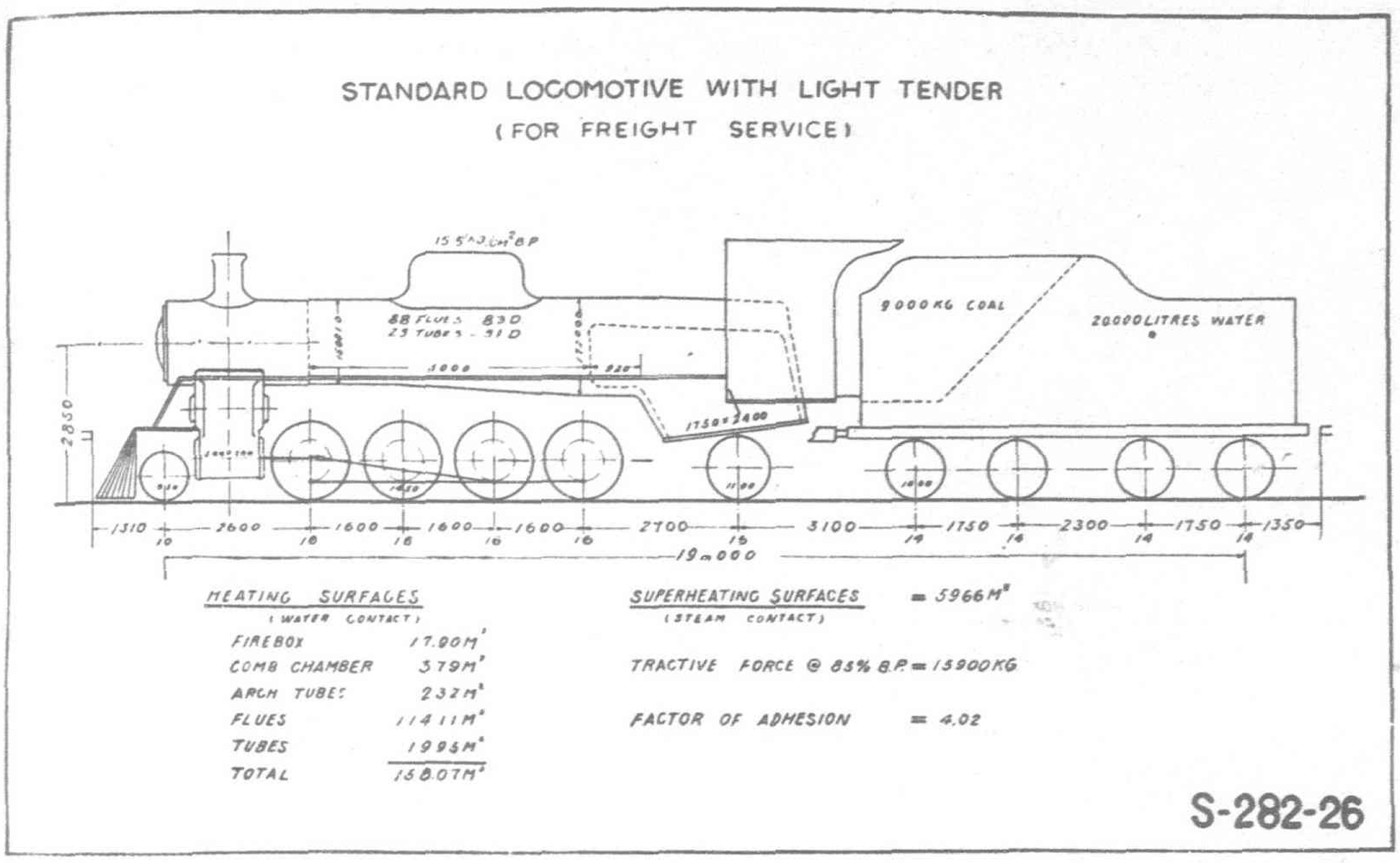
The proper handling of brakes is also a problem which requires knowledge, experience, and judgment in order to eliminate damages to stocks and lading and discomfort to passengers. Our railways have received complaints after complaints from passengers who had been kept awake all night due to rough handling of train when starting and stopping, and such discomfort still remains with us as a part of the necessary evils of railroading. But if our drivers were taught to understand what happens when he shifts his brake handle from one position to the next, and what he should do to take up the slacks of the cars behind him, it would not be impossible for him to see how to start and stop a train smoothly without having to be noticed by the passengers.

There is an appreciable difference between expert firing and unskilled firing, and this difference may easily amount to as much as 20 per cent in the capacity of a locomotive under our existing conditions. The element of human weakness makes skillful firing possible only part of the time, and the limitation of muscular capacity practically limits the rate of firing to about 1,500 kg. per hour. So, in order to realize the maximum available power of a locomotive requiring a firing rate exceeding 1,500 kg. of coal per hour, it is necessary to resort to mechanical stoking. Mechanical stokers for locomotives have been developed to such a degree of perfection that by a simple manipulation of a few valves, they will be able to perform the act of firing so perfectly that only expert firemen are able to duplicate, and they can be designed to deliver coal up to 11.5 tonnes per hour which is far beyond the capacity of any fireman. As they are devices designed to help the railways to get the most out of the locomotives and to reduce the labor of every fireman and improve his work, they should be indispensable to economical operation, only if our firemen will use them in accordance with instructions.

The care and maintenance of rolling stocks deserve even more consideration than their proper operation, for not only is the economy of operation affected by ill-kept and poorly maintained stocks but safety, the most essential feature of railway transportation, may also be jeopadized. A failure of a small part such as a cotter pin, may result in a very serious accident, which will not only damage the stock concerned, but also the neighboring vehicles, the track and other structures nearby, and, perhaps, injuries to the passengers and passers-by as well. Even a small " ailment " like hot box can cause sufficient annoyance to a railway by tying up its traffic with subsequent economic loss. One can, therefore, imagine the consequences of a more serious failure such as a broken crank pin with locomotive at full speed. To minimize stock failures on the road, constant and systematic inspection becomes absolutely necessary, for the principle of "a stitch in time" and "an ounce of prevention," when faithfully followed, will surely result in a substantial reduction in the cost of maintenance and prevent many costly accidents which might happen as a result of stock failures due to persistent neglect.



The quality of materials, such as oil, waste, packing, etc., used in the operation and maintenance of rolling stocks exerts a great influence upon their economy. Engineers are constantly



in search of materials of better quality so as to extend the time between each shopping, and to ward off troubles and failures; whereas our railways have been engaged in the practice of false economy in an attempt to realize a small saving by modifications to our engineers' specifications or substitution of something for that which is specified, resulting in added expenses and troubles which greatly offset the small gain from the reduced prices.

Economy from Efficient Repairs

When the rolling stocks are new, the cost of their maintenance is practically negligible, and as their age increases, this cost increases also. Since the rate of increase in the cost of maintenance varies rapidly as their age is increased, it is apparent that this cost will reach such a point as to render the continued operation of these stocks too expensive. It is, then imperative to send them to shops for repairs, where they can be rebuilt for thousands of miles of economical transportation.

To do the repairs most efficiently and economically, the repair shops must be laid out and equipped according to the requirements most suited to the design of each type of rolling stocks. It is hardly possible to expect a locomotive repair shop, doing repairs to a variety of locomotives, to turn out even a perfect job, to say nothing of economy and efficiency, because of the improper layout and the ill-suited equipment in combination with a system of production improvised to fit the job to the layout and the equipment. In such a shop, most of the time and energy is consumed in lost motion and in the handling of the job and the materials.

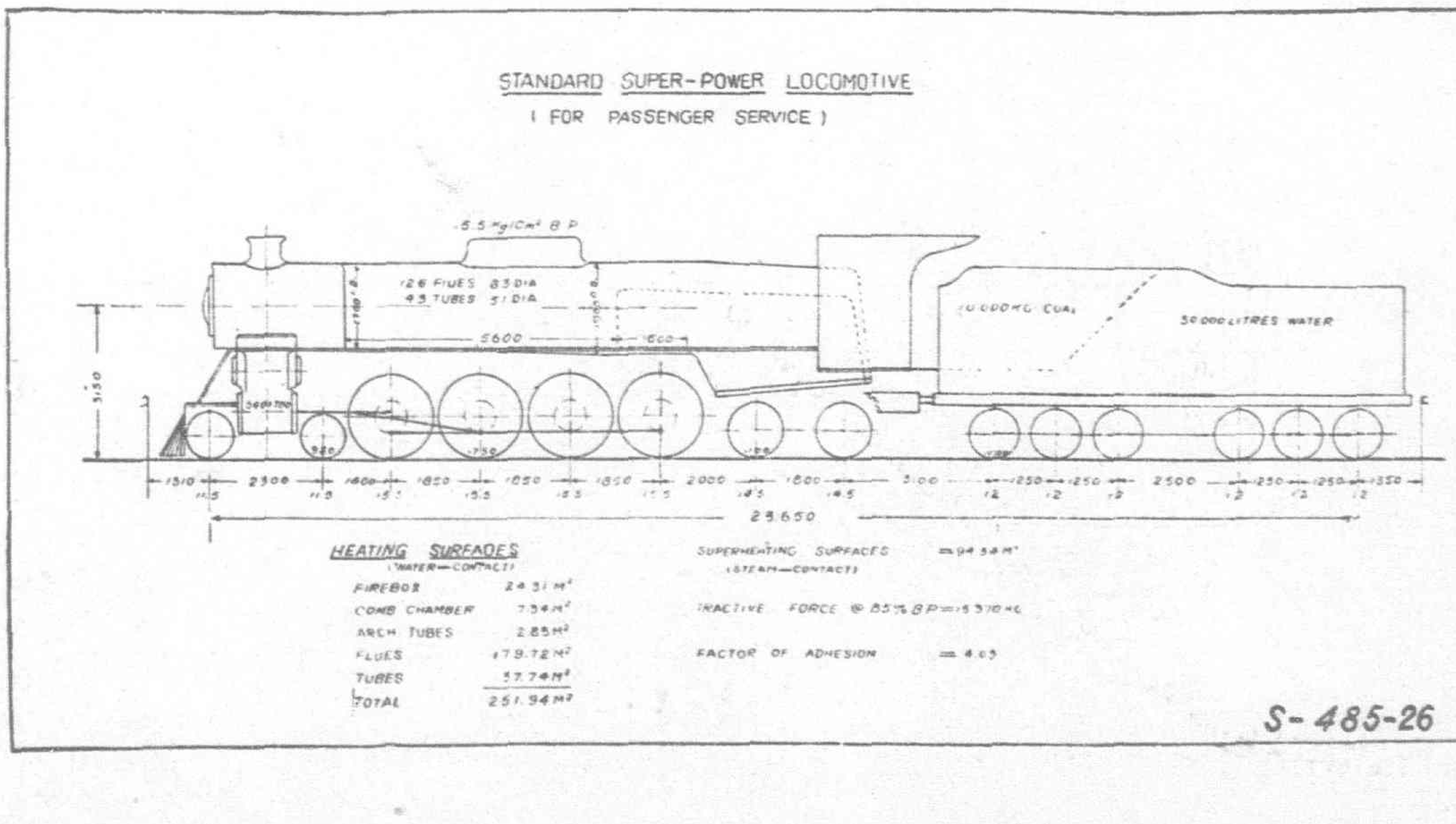
The writer had been very much impressed with the contrasting conditions of two railway shops in which he had the opportunity of acquiring some experience during his earlier days. In the first shop, he was assigned a job and left entirely to his own wit, figuring out what tools were required and the method to be followed in performing the job. The layout of the shop was poor and the system was even poorer, as most of the time was spent in getting the job started. In the second shop, he was assigned a job with a card, printed with complete instructions showing the operations required to complete the job, together with a list of tools, and the time necessary for each operation. To his utter surprise, he was able to finish every operation within the prescribed time with no special physical exertion. If he were to perform the same job in the first shop, it would have taken at least twice the time with double the effort to accomplish. For an average machinist, the time and effort would have been easily trebled, if that job were left to be accomplished by his own wit, but by following the instruction card, he would be able to complete the job like an expert machinist in a much less time.

The instruction card for each job is just a small part of the engineered details which increase production and decrease the cost of production. Each operation is carefully studied and planned, eliminating all unnecessary movements and making all necessary movements straight and direct. Even the factor of fatigue, the weakness of human labor, has to be carefully considered and a proper allowance is introduced for rest and recuperation of muscular energy.

Only by extending the engineering principles of the instruction card to the repair of a complete locomotive or car, shall we be able to realize the full economy from repairs. A repair shop, in order to be efficient, must be designed, equipped, and laid out for "straightline" production, bringing the job to the tools instead of the tools to the job, thereby reducing the amount of handling to the minimum. Further economy can be effectively achieved through specialization of men and machines, that is, each machine designed to perform one particular operation and each man trained to do one particular job. The specialization of men and machines will result in high accuracy of finish and in first class workmanship, in addition to the high efficiency and speed in production. But if a repair shop is required to deal with rolling stocks of a great variety of designs and constructions, such as those stocks in common use on our railways to-day, a substantial amount of time and energy would have to be consumed in adjusting the machines and the men to perform the variety of necessary operations. It is evident, therefore, that to achieve the utmost in the economy and efficiency in the repairs of rolling stocks, standardization of parts becomes absolutely necessary, so that special machines, tools, jigs, and fixtures can be designed together with special production methods and system devised to suit the particular designs of standardized rolling stocks.

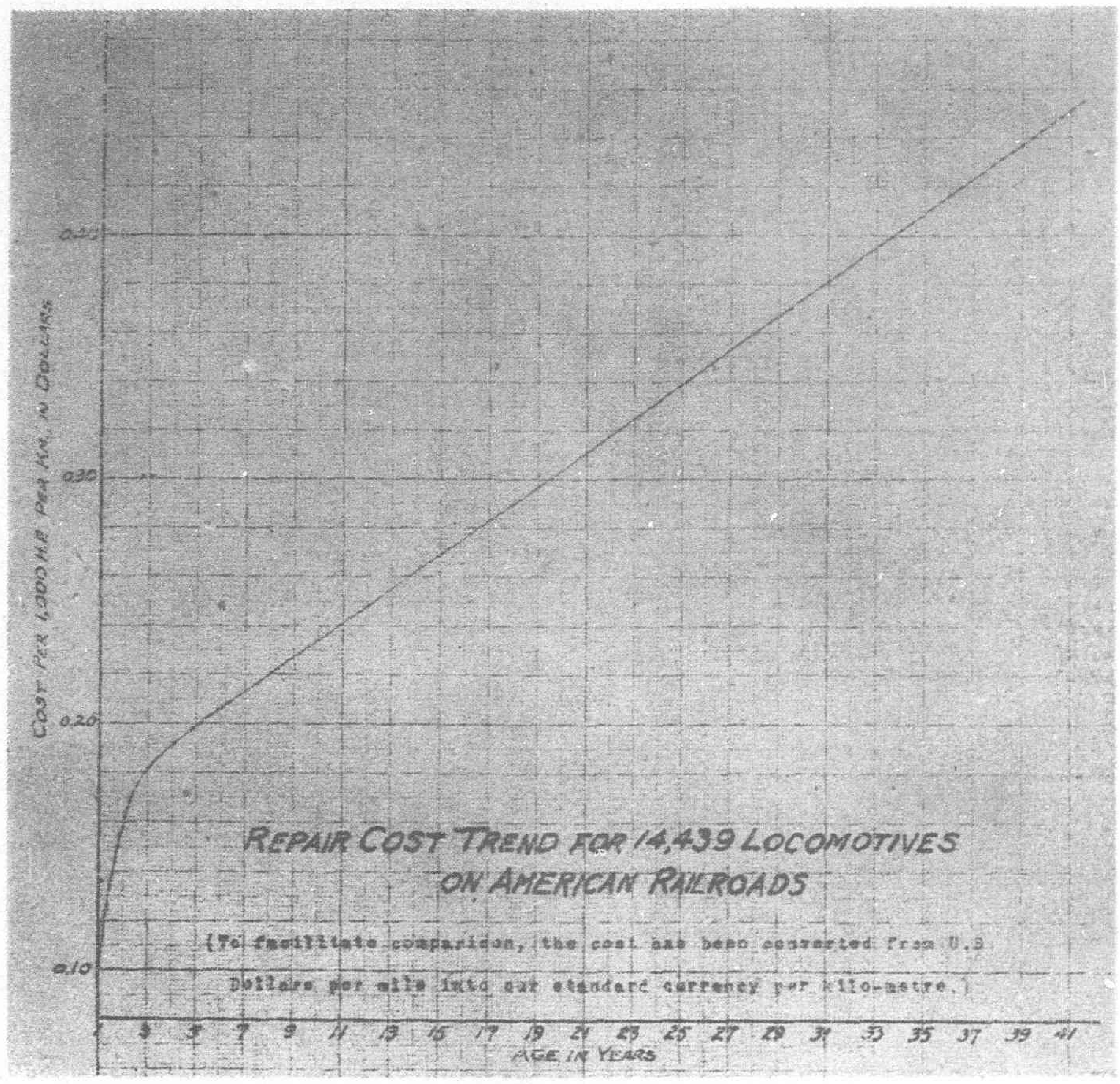
Standardization, the Basis of Real Economy

As an example of standardization, the writer proposes six standard types of locomotives, which will be able to cope with all our traffic requirements and our track conditions for many years to come. From the principal dimensions shown in the accompanying figures, it will be clearly seen that although there are six distinct types of locomotives, all the corresponding details of these locomotives can be designed to interchange with each other, with only very few exceptions. For this set of locomotives it is possible to design one repair shop which will repair any one of them with the maximum efficiency and with the utmost economy. In addition,



the maintenance on these locomotives can be greatly simplified, and the cost of maintenance is thereby reduced to the minimum by virtue of the similarly in their design and operation. And, if designed in accordance with the principles outlined above, they will be the most economical locomotives to operate.

The advantage of standardization does not stop at the reduction of cost of operation, maintenance, and repairs, which is small in comparison with the enormous reduction in price made possible by purchasing the "wholesale" lots, the most powerful leverage of the buying public. With the great variety of stocks on each of our railways, there is no way of taking advantage of "wholesale" prices when we have to buy everything in "retail" lots. For instance, we have such a variety of wheel sizes on our railways that it is only possible for us to order a few pieces of tyres for each of the different sizes at one time. Since the adoption of the meter wheels as standard for all our coaches and 840-mm. wheels for all our wagons, we have been able to purchase tyres for these wheels in larger quantities than heretofore, but still not large enough to show an appreciable reduction in prices. If standardization can be fully carried out, only eight sizes of wheels will be required for all our rolling stocks. Then, instead of buying the tyres by pieces, we will be able to buy them in thousands of pieces at one time for all our railways. Manufacturers will then be able to furnish these tyres strictly in accordance with our specifications at rock bottom prices, made possible purely by the reduction in the cost of manufacturing through quantity production, with no sacrifice in quality or workmanship.



Limitation of the Economic Age

Finally we must not overlook the action of time upon materials, for no matter how good the quality of a material may be, it will not stand the deterioration due to ageing, although the better the quality the longer will it last. Thus, many of the parts in a locomotive or car are subject to constant renewal due to constant wear while their related parts, being subjected to practically no wear, are expected to last the life of the stock. It is evident, then, when renewals and repairs to these parts become too frequent, due to deterioration of their related parts, thereby increasing the cost of their repairs to such a point as to contribute heavily to the cost of producing transportation, this locomotive or car has reached its economical age and should be retired, for its continued operation will be a burden to the railway instead of an asset. The general trend of the variation of cost of repairs with respect to age may be represented by the accompanying chart, derived from an investigation of 14,439 locomotives on the American railroads. The character of this curve will, of course, be affected by the quality of materials and workmanship entering into the construction of the rolling stocks. From this, it will be quite clear that it is poor economy to purchase cheap rolling stocks which have short economic life.

Conclusion

The foregoing is a brief discourse on what mechanical engineers are able to contribute toward the economy of railway transportation. The few methods introduced and instances cited in connection with the design, operation, maintenance, and repairs of rolling stocks are brought out here only to illustrate how this economy can be effectively achieved through sound engineering principles. Although, heretofore, the handling of our railway transportation has been distinct violations against these principles, there is still a tremendous amount to be saved from the huge sums to be spent in the future field of railway transportation in this country, for, in view of the size of our country, our present railroads are but a very small fraction of the entire system of railway networks which will be built in the future. Now is the time to cast aside the existing practice of false economy, and forget this museum of rolling stocks of old-fashioned designs, the primitive methods of maintenance, and the antiquated system of repairs, and start a new page for efficient and economical railroading.

JAPAN'S STEEL INDUSTRY

Japan's list of imports of iron ore includes supplies from Malaya, China, Korea, Manchuria, the Philippines and Australia. South African and South American sources are also being investigated; in fact, Japan is putting forth strenuous efforts to secure ore from every possible source.

It is reported that Mr. Henry Ralph, managing director of the Tasmania Steel Manufacturing Company, Australia, during a recent stay in Japan, proposed the joint working of a promising iron mine in Tasmania to Mitsui Bussan Kaisha, which has decided to make a close investigation. The mine is said to contain deposits amounting to 23,000,000 metric tons. Another report states that Mr. Akira Seo, managing director of the Nomura Securities Company, Osaka, has acquired an iron mine in French New Caledonia and has contracted to supply the Japan Steel Tubing Company and Kokura Steel Works 150,000 metric tons a year each. The mine is said to contain about 200,000,000 tons of ore of a comparatively high grade. The development is watched with keen attention in connection with Japan's southward economic expansion. The South Sea Iron Mine Company, affiliated with the Japan Steel Tubing Company, has decided to increase the yearly output of a mine it controls in the Malay Peninsula from 100,000 metric tons to 150,000 next year and then to 300,000 by 1938.

Extensive development is also proceeding at Bukit Besi, where 50,000,000 tons is reported to be available on the surface and it is reported that the Nippon Mining Company is aiming at an additional output of 250,000 tons this year. Work is going ahead on a large pier, which will permit lighters to load at low tide.

Further developments are also expected by the Ishihara Sangyo Koshi, Ltd., in Johore, and, of course, there was last year's speeding-up of output in Trengganu, which went to Japan and raised the Malayan output by more than 200,000 tons to 1,612,309 for the twelve months.

The Ryuho Coal Mine

WHENEVER coal mines are mentioned, so must Fushun. This veritable mining metropolis of South Manchuria lies at a distance of 35 kilometers east of Mukden. It plays an important part in the economic life of Manchuria as a huge investment enterprise, the operation of which is of vital concern to more than one investor, but the greater importance by far lies in the great coal output that is relied upon by many an industrial plant in Manchoukuo and Japan as the primary motivating agency.

Widely known for open-cut mining which finds no par anywhere, the Fushun coal fields cover an extensive area of 60,160,000 square meters with an amazing estimated deposit of 1,000,000,000 metric tons.

The fabulously rich coal deposits at Fushun were first discovered some six centuries ago by Koreans who actually began mining under an extremely primitive method, but later the superstitious Manchu monarchs forbade further exploiting operations, lest the spirits of their departed ancestors whose graves were in the vicinity, be disturbed from their peaceful repose. When the Russians launched their aggressive Far Eastern policy, they immediately dismissed such superstitious restrictions, and completely ignoring the earnest entreaties of the Manchus, began resumption of mining activities at Fushun, but still, the scale and output at this stage were considerably small and limited.

Breaking the breathless tension of the Russo-Japanese War, Japan emerged the victor, and as one of the results of this great struggle, she acquired full rights to exploit the Fushun coal fields. The South Manchuria Railway Company, to which the management of the collieries was entrusted, soon effected extensive improvements and introduced modern scientific methods. A number of pits have been sunk, and the work on the open-cut fields greatly intensified.

It is quite impossible to make an adequate treatment of the whole Fushun coal mines within such limited space and time, since the materials that the writer hopes to present in order to give full justification to the subject, are literally inexhaustible. For this reason, he will endeavor to give a brief account on the new Ryuho shaft mine, one of the several that compose the Fushun coal fields, and from this he hopes that the size, importance and the magnitude of operations of the combined coal fields can be obtained.

Located at the eastern extremity of the Fushun coal fields, the Ryuho mine runs five kilometers from east to west and has an estimated coal deposit of 250,000,000 tons, or about one-fourth of the total deposits of the Fushun coal fields. The coal seam is from 20 to 30 meters thick. The coal, being fairly adhesive, is used for making coke and is chiefly supplied to the Showa Iron and Steel Works at Anshan. An analysis of Ryuho coal shows that its humidity is 1.53 per cent ; caloric value, 7.32 calories, and contains 41.93 per cent of volatile matter, 9.36 per cent of ash, and 46.55 per cent of fixed carbon.

Two double-compartment shafts have been sunk near the center of the coal field 60.6 meters apart. Each shaft is 6.5 meters in diameter and 370 meters deep. Only one of them, namely that on the east side, is in operation at the present, and according to further plans, the output for the present fiscal year (April 1937-March 1938) was expected to reach 1,150,000 tons, which will be increased to 1,500,000 tons next year, giving a daily production of 5,000 tons.

With the installation of a hoisting equipment for the west shaft in the future, an additional 5,000 tons will be brought up daily. Several years hence, it is planned to sink the east shaft further to a depth of 770 meters and the west shaft, to 570 meters.

In connection with the plans drafted before the mine was brought into operation, considerable experiments and study along dynamic lines were conducted, since the maximum coal output was desired.

For a long time, there was much argument as to the winding method to be used in hoisting the mined coal from the bottom to the surface. There were four methods to choose from : the skip, the cage, the drum, and koepe winding systems. It was found that the percentage of crushed coal was high in the skip system, while the drum method necessitated drums of eighty tons in weight, giving rise to a problem in their manufacture. Bearing these shortcomings in mind, the cage and koepe methods were finally adopted. Moreover, the tower-winding system was utilized to prevent slipping of the lines due to the formation of frosty impedimentary coatings over the cable lines in the winter.

The Ward Leonard system is used in the control of the winding operations, capable of lifting 12.2 tons, or eight coal cars in four layers, at a single hoist. When hoisting men, a total of 120 persons can be accommodated. In other words, it is a gigantic coal elevator shaft.

This huge elevator extends only a little more than sixty meters above the ground, but since its main function is underground, the total vertical distance of movement is 382 meters for the first stage, and eventually 782 meters in the future. In speed, it travels 11.5 meters per second (40 km. per hour), but in the future the distance per second will average 23 meters (80 km. per hour). Loading operations require only eight seconds.

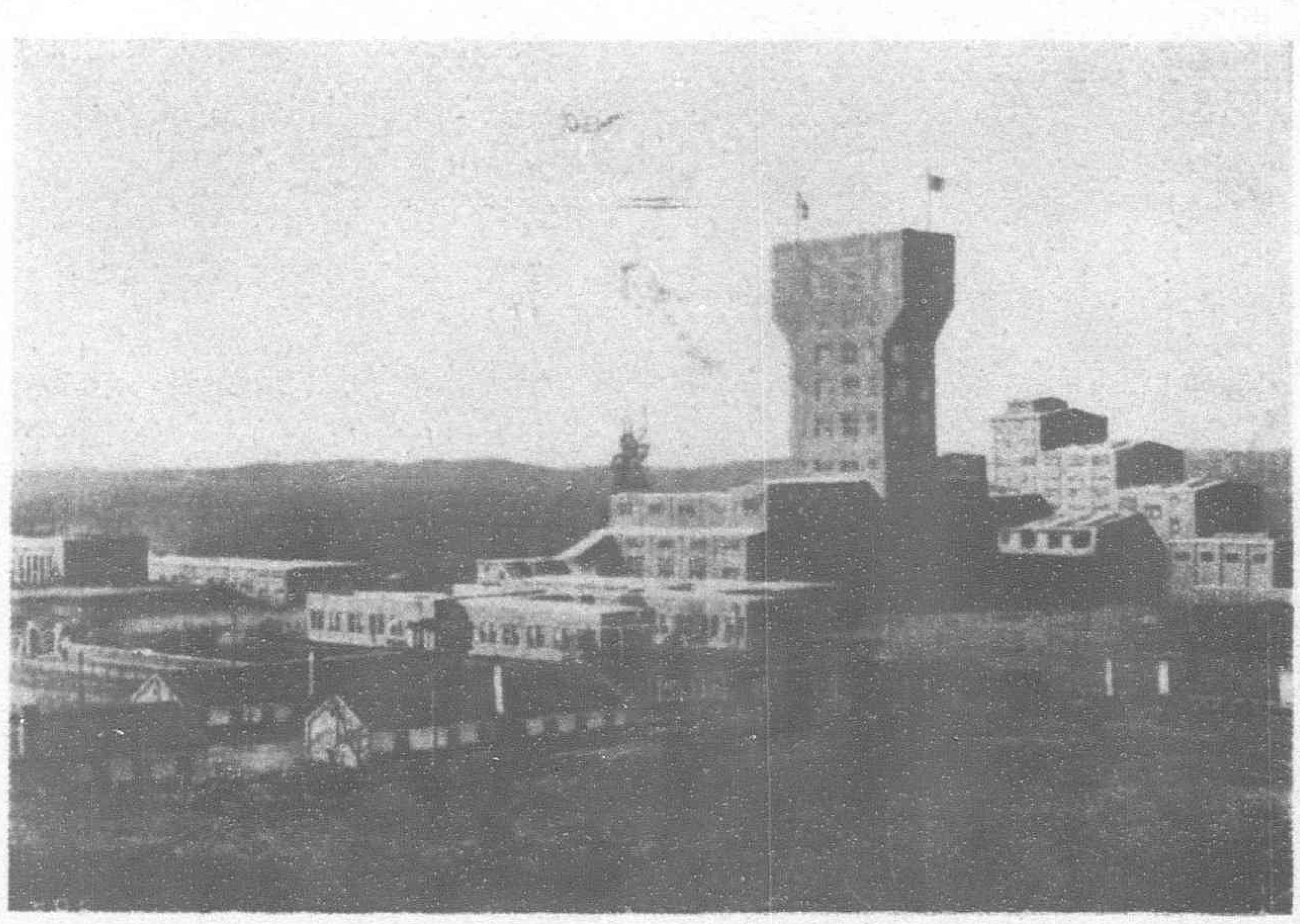
The winding for the present is 53 revolutions per hour, while that of the second is a little less, or 46 which is due to the lengthening of the distance to be covered. Consequently, the amount of coal brought to the surface within an hour is 650 tons for the first and 560 tons for the second.

The diameter of the cable that facilitates the winding, measures 71 millimeters or the size of an ordinary stitched baseball, a size of a steel line that is rarely made and undoubtedly the largest in the world. This huge rope makes 53 windings in an hour.

The electric generator that supplies the motivating power for the winding operations has a capacity of 5,395 horse-power, and the huge koepe pulley over which the line is slung, is 7.5 meters across, while the guide pulley measures 6.5 meters in diameter. Six and a half meters is equivalent to the combined height of the average four persons. It is rather difficult to imagine anything of such magnitude spinning away in mid-air at the top of a lofty perch 60 odd meters off the ground.

The weight of the cage alone is 17.175 tons, which naturally makes the ordinary person wonder how such a device of so tremendous weight was ever lifted and placed in a place 60 meters high. There is in fact little to be surprised at, since the cage was lifted by cranes to the lofty perch in sections and then installed there, but even at that the task does not seem by any means to have been a simple one.

The actual height of the winding tower is 63 meters and the width is said to range from 15 to 30 meters. Work on the steel construction of this great tower was begun in July of last year, and the brick parts completed on July 2 of this year.



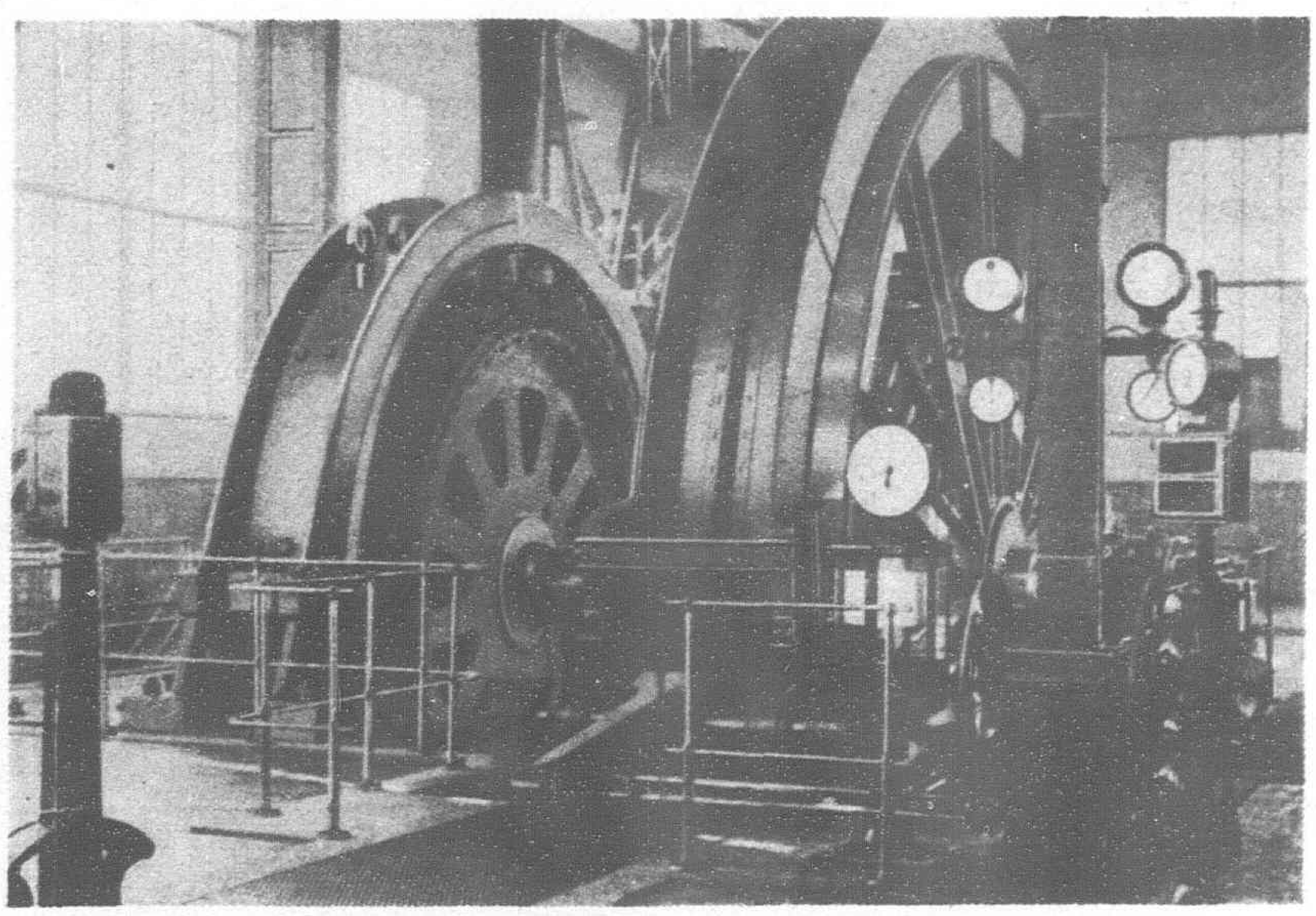
Panorama of the Ryuho Coal Mine, Fushun. Note height and size of the huge winding tower

The interior of the winding tower is well lighted through the wide and numerous glass windows. Externally, it gives one the feeling of flatness, similar to that of a stage setting, which is due to the absolute absence of decorative touch in the construction of the walls. The glass windows look no larger than ordinary ones, but should one stand close to one of them, he would find the window much taller than himself. Furthermore, this new mine boasts the possession of a peerless heating system which, together with its name, has come to be known to the world.

This gigantic winding tower of Ryuho ranks quite comfortably in scale with those of the German mines, Minister Stein and Zollverein, but in the cage winding system, it ranks second to none, as the following comparisons reveal.

In height, it shares honors with the German mine Koenigsborn, both reaching an altitude of 67 meters; second in order comes Hannibal (Germany) at 63 meters, Minister Stein at 62.4 meters, and Hohenzollern at 56.9 meters. The height of the main operating floor of the Ryuho tower is 50 meters from the ground while that of the German Koenigsborn is 55 meters. The method employed is exclusively the cage system.

Ryuho's single coal load uplift weighs 12.22 tons, while the German mines Koenigsborn and Minister Stein pull up 11.7 and 8.4 tons respectively. The other mines average about five tons. The total tons per hour of Ryuho average much more than those of the German mines which were compelled to suffer the unpleasant subjugation at the hands of a new but powerful rival in the form of Ryuho. Figures show that Ryuho's tower hoists 650 tons in one hour, but that of Germany's Koenigsborn, which reigns supreme in height with Ryuho, is 293 tons or only 40 per cent of that of the latter. However, there are others of more capacity in Germany like the 420 tonner Minister Stein, and the Hohenzollern which averages a trifle less. In size or capacity the tower of Ryuho commands the undisputed supremacy over all others.



Gigantic Hoist on the uppermost story of the winding tower. The diameter of the wheel-like hoist is 7.5 meters

In order to insure the smooth and efficient functioning of so great a mechanism, it is necessary to have corresponding electrical power equipment. In the case of Ryuho, the power capacity is the greatest in the world with 4,025 kw. Those of the German mines are 2,100 kw. at Koenigsborn, and 1,320 kw. at Minister Stein. There is no wonder then that such a difference exists in coal ton uplift between then ew Manchurian mine and those of other countries.

As early as 1909, electricity was first employed in the winding up process at Fushun, but at that time no satisfactory operation was obtained due to the undeveloped state of gear manufacturing. However, following the successful creation of the helical gear in 1916, a marked improvement in the efficiency of electric winding was effected to such an extent that to-day, twenty-five years since the inception of electricity, the total capacity has reached 14,340 horse-power, and more recently 20,000 horse-power through the addition of the Ryuho mine shaft.

The main mine-passage or tunnel lies at a depth of 370 meters, and the initial mining stratum extends 100 meters into each section above and below this horizontal underground passage. The upper 100 meters will be mined first, the operation to be carried from the west towards the east, using incline cables for transportation to the horizontal tunnel. Under normal conditions three mechanical drills will be used resulting in a contemplated output of 5,000 tons daily.

The tunnel runs through layers of shale or basalt, and the arch of the passage is supported with steel beams, and except in places where the earthen walls are loose, steel reinforced concrete or brick coverings are worked into the ceilings and sides. The width of this tunnel measures 6.1 meters while the height is four meters.

The hydraulic filling method is to be adopted in this mine, using discarded oil shale as material. Therefore, nothing is wasted at the Fushun coal mines.

Transportation of coal from the beds to the grading point on the surface is conducted by mechanical automotive power, requiring no physical exertion at all. The mined coal is sent from the bed to the chute, then to the incline tunnels by means of belt conveyors; from there it is sent sloping down to the main horizontal passage tunnel. Here the mined fuel is loaded onto electric rail cars which in turn enter the cage for the surface ascent. The electric cars are run over a distance of approximately two and a half kilometers. After the cars are brought to the surface (370 m.) by cage winding, they are transferred onto a higher platform on the way to the coal-grading station.

The electric locomotives employed in the mine are of the trolley type; 210 volts, 300 amperes, and weigh ten tons per locomotive. Seven of these are to be employed. Up to this time five ton cars of uniform standard size and capacity had been in use at Fushun, but in the new Ryuho shaft the adoption of the ten ton cars was decided upon as the result of lengthy considerations, at the same time widening the gauge from 610 mm. to 750 mm. The collieries at Ryudai, Togo, Oyama, Mantatsuya, and at Yentai use the five ton cars. Adoption of the ten tonners at Fushun is indeed a novelty.

The contrapositive type is incorporated in the ventilation system whereby fresh air is " inhaled and exhaled " into and from the mine shaft by means of electric fans located at the east and west openings. The east-end fan will be installed when work is commenced on the eastern shaft. With a generation of 700 horsepower, the western end fan is capable of sending 15,000 cubic meters of air astir.

At the grading station, the coal is graded as the term signifies. The only difference at Ryuho lies in the scale, that is, the amount of coal handled within an hour, which is about 526 tons, relying upon the central-signalling system. Differentiation between lump and crushed coal is made according to the Rheolaveur Process.

Electric power transmission at the Ryuho shaft mine is conducted by the latest method which is based upon experiences with past methods. The surface electric power capacity in 1936 was 2,500 kw.; in 1937 and 1938, an increase to 3,400 kw. is expected, while power actually used in 1936 amounted to 2,000 kw., but in 1937 and 1938 this phase will reach 2,700 kw. In the future a still greater increase is expected, reaching a total of 9,000 kw. capacity and 8,000 kw. usage when the total daily coal output is contemplated to reach 10,000 tons.

The interior capacity reached 5,000 kw. in 1936. The expectation for 1937 is 7,000 kw. and for 1938, 7,200 kw. while 14,000 kw. is being worked toward in the future. The actual power usages are: 1936—28,000 kw., 1937—4,350 kw., 1938—4,800 kw., and the eventual goal lies at the 10,000 kw. mark. Thus the combined surface and interior power will reach 23,000 kw. capacity, and 18,000 kw. actual consumption by the time the 10,000 tons per day output becomes a reality. It can easily be seen that such a heavily powered electrical plant is very rare for a coal mine establishment. When the 23,000 kw. level is reached it will be equivalent to the 20,000 kw. power transmission between Dairen and Kanseishi.

To effectuate the uninterrupted transmission of so great a volume of electricity, a new line from the Takuantun power plant (44,000 kw.) was set up; and two 10,000 kva transformers were installed at Ryuho transmitting 6,000, 2,000, and 200-volt currents. There is also a separate unit of 2,140 kw. provided especially for the winding tower.

(Continued on page 409)

Survey of the Coal Mining Industry in Manchuria

COAL mining in Manchuria has quite a long history as is indicated by records, showing that coal had been in use in Manchuria much earlier than in Japan, but it was rather localized and conducted on a small scale.

Coal mining as an industry was inaugurated by Czarist Russia, when she launched her aggressive Far Eastern policy, but her operations were soon brought to a termination. Since then the industry, as far as the Manchu mines are concerned, has until recent years made very slow progress owing to political and economic obstacles placed in the way of its development by the former Northeastern régime. On the other hand, the growth of the coal mines owned by Japanese has been rapid. Representative of these mines is the world-famous Fushun coal fields whose course of development may be regarded as the history of development of Manchuria's coal mining industry. Ever since the Fushun mines were taken over by the South Manchuria Railway Company in 1908, their output has steadily risen as the following figures show :

Year	*Production (1,000 tons)*	*Year*	*Production (1,000 tons)*
1908	490	1923	5,000
1909	690	1924	5,600
1910	900	1925	5,810
1911	1,320	1926	6,690
1912	1,470	1927	7,190
1913	2,180	1928	7,550
1914	1,150	1929	7,690
1915	2,170	1930	7,200
1916	2,060	1931	6,520
1917	2,340	1932	6,270
1918	2,580	1933	7,950
1919	2,780	1934	8,660
1920	3,170	1935	8,380
1921	2,810	1936	9,590
1922	3,840		

Taking the 1912 output as the basis of comparison, the rapid increase in production may be perceived from the following tabulation :

Year	*Production (1,000 tons)*	*Year*	*Production (1,000 tons)*
1912	100	1926	451
1916	145	1930	490
1921	192	1936	650

Coal Deposits in Manchuria

According to an estimate made by the S.M.R. Geological Institute at the end of 1929, the total coal deposits in Manchuria amounted to 4,800,000,000 metric tons. With the restoration of peace and order since the birth of the new State, an extensive survey has been made, and in consequence, a number of new mines has been discovered and opened that to-day the deposits, it is estimated, amount to 10,000,000,000 tons at least. Many rich coal fields are expected to be found as further surveys are made in the future, raising the aggregate deposits still higher.

General Condition of the Principal Coal Mines

The principal coal mines which are actually under exploitation to-day are Fushun, Yentai, Penhsihu and Hsian in Fengtien Province; Fuhsin and Peipiao in Chinchou Province, Holikang in Sanchiang Province, Mishan and Muleng in Mutanchiang Province, and Chalainoerh in North Hsingan Province. Others of considerable importance are Huoshihling, Chiaoho, Laotoukou, Niuhsintai, Fuchou and Pataokou. The majority of these coal mines is exploited by the South Manchuria Railway Company and the Manchuria Coal Mining Company, established in 1934. Chief among the former's are Fushun and Yentai, while the principal mines owned by the latter are Fuhsin, Hsian and Holikang. In the accompanying table are given the estimated deposits (in million tons), the geological age and the kinds of coal of the principal mines.

Mines	*Geological age*	*Nature of coal*	*Estimated deposits*
Fushun	Tertiary	bituminous	950
Yentai	Permian	semi-anthracitic	40
Penhsihu	,,	bituminous	220
Hsian	Jurassic	bituminous	600
Fuhsin	,,	,,	4,000
Peipiao	,,	,,	300
Holikang	,,	,,	600
Mishan	,,	,,	300
Chalainoerh	,,	lignite	400
Muleng	,,	bituminous	300

Coal Output

As the following table which gives the total coal production in Manchuria for the past ten years shows, the output has steadily increased since the establishment of the new State in 1932.

Year	*Amount (1,000 tons)*	*Year*	*Amount (1,000 tons)*
1927	9,510	1932	7,740
1928	10,210	1933	10,150
1929	10,530	1934	11,420
1930	9,860	1935	11,820
1931	9,200	1936	13,600

The 1936 production, classified according to ownership of the mines, was (in 1,000 metric tons) :

(*a*) Collieries operated by the S.M.R. Company—

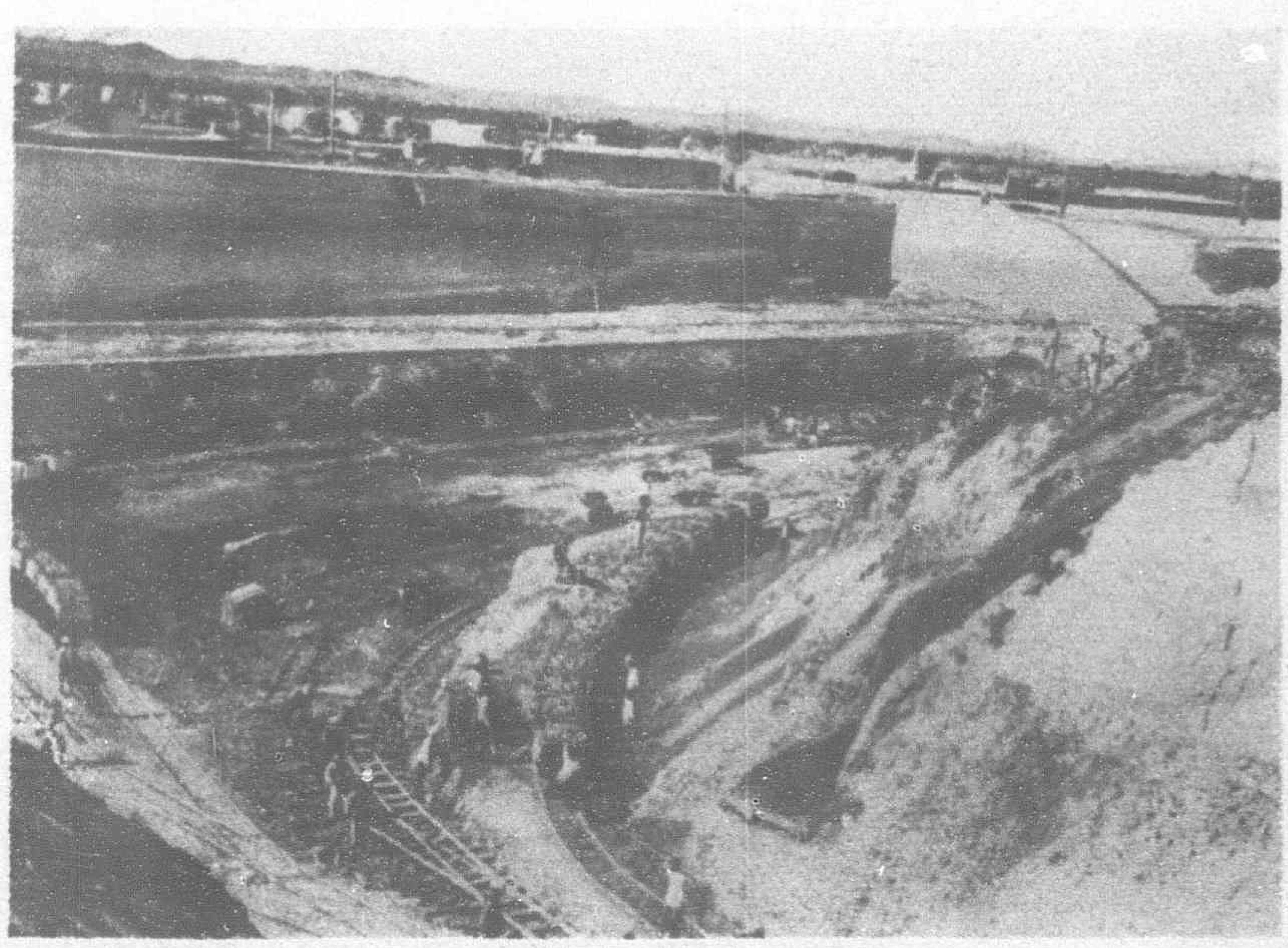
Fushun	9,594
Yentai	310
Others	348
Total	10,252

(*b*) Collieries operated by the Manchuria Coal Mining Company—

Hsian	894
Holikang	343
Peipiao	293
Mishan	61
Fuhsin	77
Chalainoerh	138
Others	389
Total	2,195

(*c*) Collieries operated by other concerns—

Penhsihu	739
Muleng	273
Others	147
Total	1,159
Gross Total	13,606



Mining operations of the Fushun open-cut mine. In the amount of deposits, it reigns supreme over all Manchurian mines, total reserves being estimated at 4,000,000,000 tons

The important part that the South Manchuria Railway Company and the Manchuria Coal Mining Company are playing in the coal mining industry of Manchuria may be perceived from the above figures which show that the combined output of the collieries owned by these two corporations comprised 90 per cent of last year's total production (S.M.R. 75 per cent, and M.C.M. Co. 15 per cent).

Demand for Manchurian Coal

The demand for Manchurian coal has steadily

grown during the past ten years, showing a noticeable rise especially after the foundation of Manchoukuo owing to a marked increase in domestic demand. Up to 1931 domestic demand fluctuated, but with the rapid rise of industry an increase in population following the birth of the new State, it has made a tremendous jump, attesting the growing prosperity of Manchoukuo. The demand for Manchurian coal, classified according to domestic demand, exports, and ship fuel, for each of the years, 1926 to 1936, was as follows (in 1,000 metric tons):

Year	*Domestic demand*	*Amount exported*	*Ship fuel*	*Total*
1926	3,760	2,850	620	7,230
1927	4,440	3,240	700	8,380
1928	4,880	3,710	710	9,300
1929	5,250	4,010	700	9,960
1930	4,650	3,830	540	9,020
1931	4,620	4,260	660	9,540
1932	4,690	3,360	780	8,830
1933	6,120	3,770	890	10,780
1934	7,250	3,900	860	12,010
1935	8,690	3,360	880	12,930
1936	9,580	2,990	850	13,420

Home consumption, classified according to the various uses, for the period between 1932 and 1936 was (in 1,000 metric tons):

Industrial use:	*1932*	*1933*	*1934*	*1935*	*1936*
Steel industry	843	921	1,134	1,489	1,631
Iron-foundry and machine manufacturing industry..	33	94	97	103	131
Chemical industry	140	117	164	254	294
Textile industry	61	64	58	63	70
Ceramics industry	154	296	403	507	561
Food manufacturing ..	115	91	86	114	207
Other industries	102	141	171	212	239
Total	1,448	1,724	2,113	2,742	3,133
Electric generation and gas manufacturing	859	951	1,103	1,181	1,311
Railways	1,050	1,290	1,581	1,808	2,044
Mining	285	362	409	477	492
Domestic and other uses ..	1,052	1,788	2,049	2,485	2,598
Grand Total	4,694	6,115	7,255	8,693	9,578

As may be noted in the foregoing table on demand, exports of coal have fluctuated, manifesting rather a downward tendency in recent years. This is due to the rapidly increasing domestic demand for the product, which has caused a shortage of output for exportation. The greater part of the exports is destined for Japan as the following export figures for the period from 1932 to 1936 show (in 1,000 metric tons):

	1932	*1933*	*1934*	*1935*	*1936*
Japan Proper	2,003	613	962	2,534	2,241
Chosen	355	411	469	579	569
China and other countries	998	737	469	249	184
Total	3,356	1,761	1,900	3,362	2,994

The demand for ship fuel has also grown due to increased shipping accompanying the rapid expansion of trade between Japan and Manchoukuo since 1932, but there has been no appreciable increase owing to the curtailment of amount resulting from the increase of local sales. The greater part of ship fuel is loaded at Dairen and Yingkou.

Future Demand for Manchurian Coal

On the following grounds the writer believes that there is every prospect of the demand for Manchurian coal continuing to grow in the future:

(1) Increasing demand for coke and coal at the Anshan, Penhsihu and other steel mills accompanying the increased production of the metal.
(2) Increased consumption of fuel for furnishing the motive power for the development of industry.
(3) Increasing demand for the pulp, cement manufacturing and chemical industries.
(4) Increasing demand for the coal liquefaction industry.
(5) Increasing demand for fuel accompanying the construction of new railway lines, the increased operation of trains, and the development of other transportation facilities.
(6) Increasing demand for household fuel owing to an increase in population.

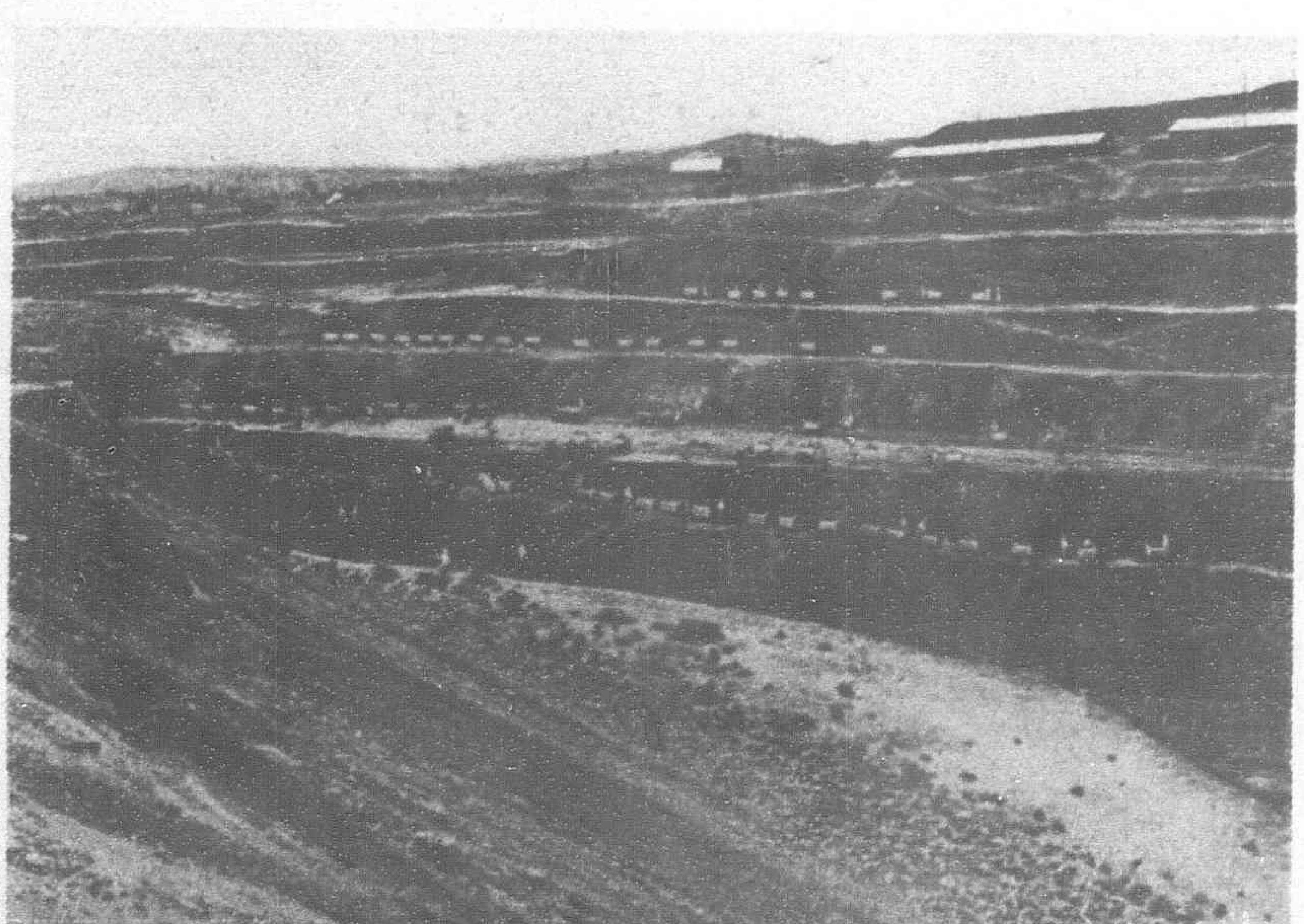
Here it is necessary to make special mention on the relation between Japan's fuel problem and Manchurian coal. Amounting to 43,500,000 metric tons last year, consumption of coal in Japan has increased at the rate of a little over ten per cent yearly since 1931. The annual demand after 1941 is expected to exceed 70,000,000 tons in consideration of increased consumption of the fuel by the heavy, chemical, coal liquefaction and other rapidly developing industries along with the expansion of productive capacity in the future.

In surveying the sources of supply, it is noted that the collieries in Kyushu, where 60 per cent of Japan's coal output is mined, have already passed their prime, while the famous Ube coal fields in Yamaguchi Prefecture seem to have reached the stage of exhaustion. Hokkaido and Karafuto (Saghalien) are the only remaining sources of supply but most of the mines in Hokkaido are found in the upper portion of mountains, causing much difficulty in mining and transporting coal, while mining in Karafuto is hindered by climatic obstacles. There are foreign coal from Kailan, Shantung, North China, and Koki but the Kailan coal is beyond the reach of Japanese influence and the Shantung mines bear legal Chinese restrictions and actual Chinese operations except a certain portion, while exploitation of the North China coal still remains a problem of the distant future due to geographic disadvantages. Shipping difficulties in large quantity importations of Koki and other foreign coal cannot be avoided in times of prosperity in the maritime traffic.

Such being the present conditions, there are no other sources of economic value besides Manchuria, not to mention the future prospects. It is not difficult then to see why Manchurian mines have become the impellent forces for the other industries of Manchuria, and at the same time, acquired an indispensable position as a source of Japan's fuel products.

Attention must now be directed to the supplying phase of Manchurian mines. In summarizing:

(1) Except for one or two cases, the greater part of Manchurian mines is in the "virgin" state.
(2) Mining based on long Japanese experiments, the recruiting of trained miners, and the employment of latest methods enable efficient mining.
(3) Since the value of land is low, open-cut mining is made possible, and consequently results in higher mining efficiency and the relatively low wages and other operating expenses.
(4) As referred to later, it is possible to conduct mining, supply, and selling transactions under ideal conditions due to the well organized system of Manchuria's coal mines.



Hsian open-cut mine owned by the Manchuria Coal Mining Company. Total deposits 600,000,000 tons

Taking into consideration the above factors as well as the great confidence placed upon Manchurian coal, which is revealed by the Japan-Manchoukuo fuel policy, the plan for increased output of coal has been made the basis, or the nucleus of, the Five Year Industrial Development Plan.

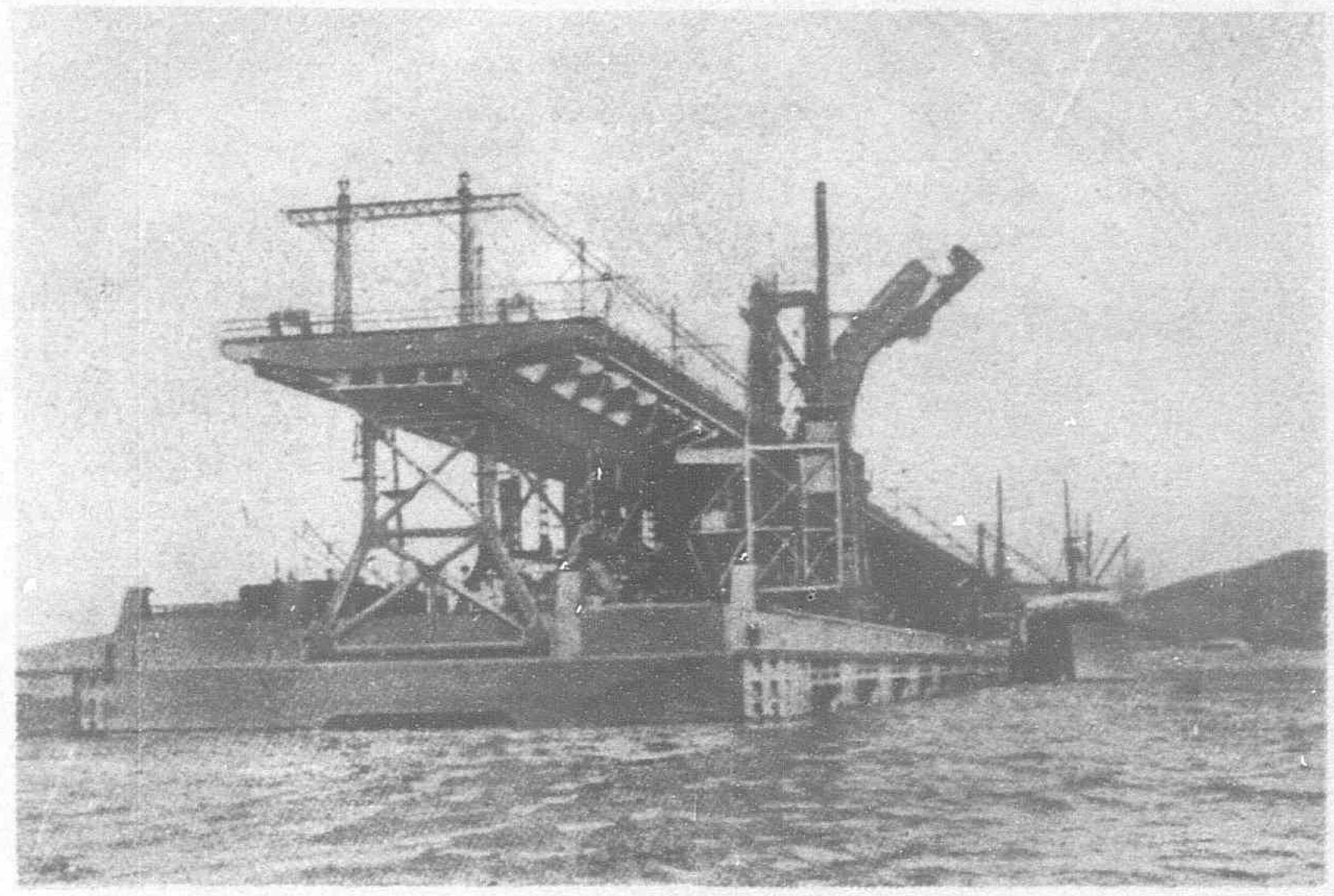
Needless to say, a marked increase in the output of mines operated by the S.M.R. Company is not expected, but the greatest efforts will be made to bring about this

result in the mines under the supervision of the Manchuria Coal Mining Company. With this goal in mind, the latter concern has increased its capitalization from Y.16,000,000 to Y.80,000,000. It is expected that within the next few years, the annual output of Manchurian mines will exceed 20,000,000 tons.

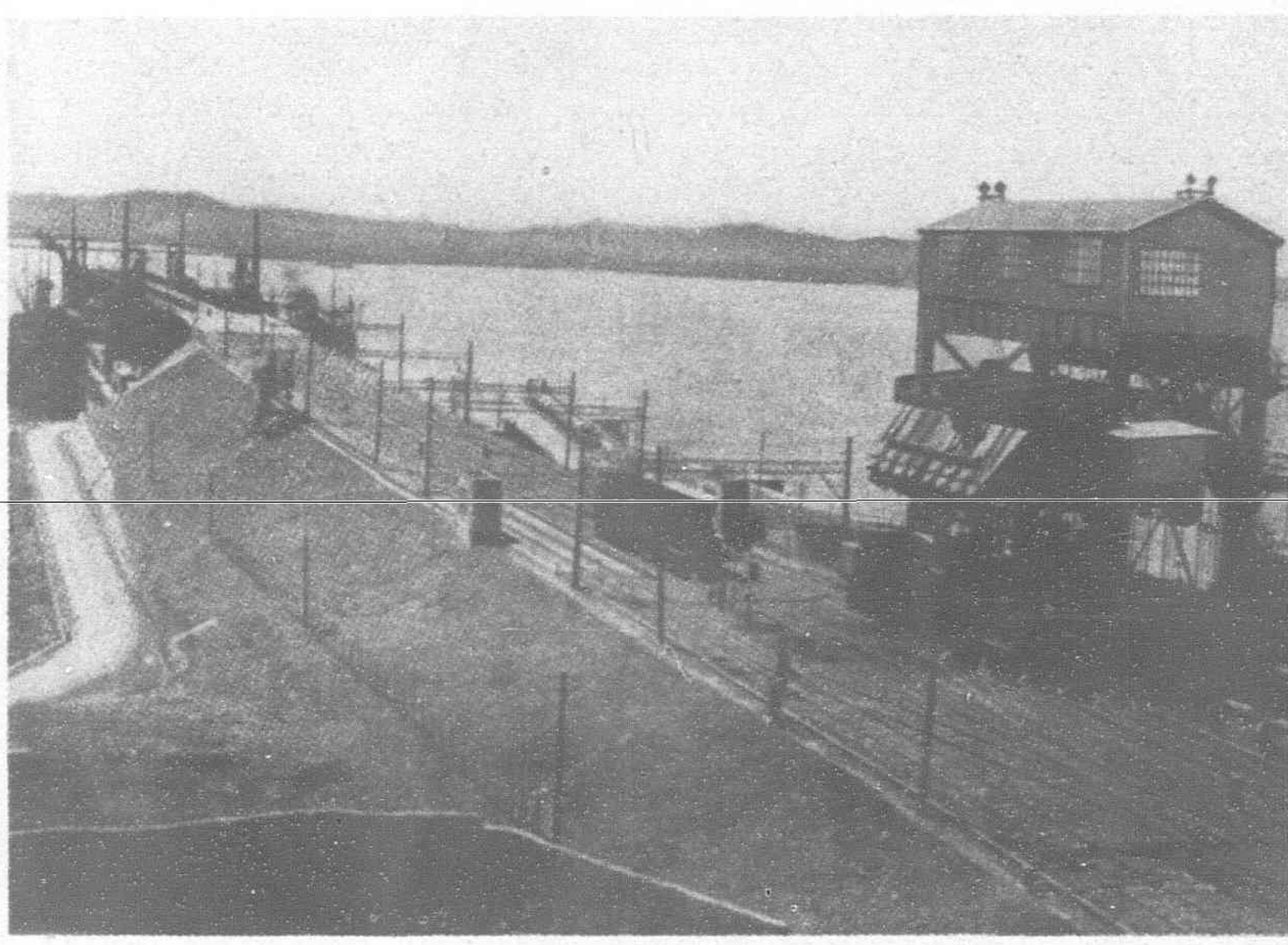
Control and Marketing of Manchurian Coal

The supplying operations as well as shipping of coal are managed by the Manchuria Coal Mining Control Committee, and are conducted systematically. This Committee was created in April, 1935, when the first meeting was held, and is composed of members representing the Manchoukuo Government, the S.M.R., and the Manchuria Coal Mining Company. It has done much toward effective unification and standardization of Manchuria's mines.

Marketing functions are handled by the Japan-Manchoukuo Trading Company which was established in November, 1936. Capitalized at Y.10,000,000, mainly subscribed by the S.M.R., the Showa Steel Works and the Manchuria Coal Mining Company, this Company handles the principal mineral products of Manchuria such as coal, iron and petroleum. These products are vital elements in the mining industries of Manchuria, and the Japan-Manchoukuo Trading Company certainly has important functions to perform. Moreover, coal occupies the greater part of the business handled by the Company. In fact it controls all the marketing of coal from the S.M.R. and M.C.M. Co. mines, as well as from the other mines of minor ownership, and supervises the exportation of coal to Japan, China and other countries, together with distribution throughout Manchuria.



Modern coaling equipment at Kanseishi



Coaling pier at Kanseishi, opposite Dairen across the bay

It has been seen that coal mining in Manchuria has followed a rather handicapped, crooked course of development, but since the establishment of Manchoukuo, this industry has progressed by leaps and bounds. It is virtually at the door-steps of a glorious stage.

Encouraged by the growth of the new State and beckoned by the ever enthusiastic demands of Japan, Chosen and other countries, coal output from Manchuria's vast reserves is increasing at a surprising rate, adding much confidence and satisfaction as a solution to the Japan-Manchoukuo fuel problem.

Taking the above observations, together with the undeniable facts relevant to the growth of Manchoukuo's coal mining industry as promising indications, a more glorious and prosperous era is prophesized.

THE RYUHO COAL MINE

(Continued from page 406)

In referring to the concerns that manufacture equipments necessary for coal mining, the following can be mentioned. The parts of the winding mechanism and winding and coal pit cages are manufactured by the German firm, Demag ; electrical equipment by the Siemens Schuckert Company, also of Germany ; and coal cars, platforms and other related material by other German concerns. All of these industrial plants produce first class capital goods.

The expenditures involved in the opening of the Ryuho mine total Y.10,000,000. Of this sum, the winding tower cost Y.1,440,000 ; the grading station Y.1,760,000 ; and other underground equipment and facilities consumed Y.2,300,000.

There is a repair shop adjacent to the office building, an unusually long structure for such a purpose, measuring 125 m. by20 m. Next to this building is the locker-room for Japanese employees. Each workman has a locker about two feet wide, and on the door of each is posted the slogan inscription, " Co-operative Harmony." A direct passage way leads to the mine from the spacious quarters.

Within the coal mine, it is quite difficult for one to maintain contact with a cordial friend of his. As the outgrowth of this situation there has emerged a practise among the men to post messages like " Sorry, I'm going home," " Will meet you at . . .—at 8 o'clock," etc., on the door of his friend's locker or whomsoever the message is intended for.

A huge bathroom lies next to the locker-room, with a mammoth tub overflowing with steaming hot water. Here, after a tedious day's work down deep in nature's hidden stratum, the tired and weary once more recall those suppressed innate human feelings and creature wants. Dust and dirt, together with paralyzing fatigue, vanish after a soothing hot bath.

The hallway from this " bathroom " leads to the Manchu laborers' quarters, where each man ties his clothing into a bundle and hands it over to a keeper after tagging it. He then proceeds through a corridor still in his completely nudist form, and receives a working outfit at a counter. This system is due to the number of Chinese workers, but the main reason is the prevention of undesirable and dangerous practises such as carrying matches and tobacco on one's self into the coal mine.

The completely equipped worker, after getting into his mining outfit and supplying himself with a straw hat and a G.S. type safety lamp, climbs the stairway leading to the winding tower and here he is lowered down to his dark day's assignments. The cages as referred to above are four-layered or storied, each story or layer accommodating 30 men or a total of 120 on a single " haul."

The initial results following the opening of the mine proved very encouraging and satisfactory. The success was hailed by all from the mine superintendent on down to the lowest rank worker. It has been reported that Superintendent Kubo has under his safe keeping in his room, the first lump of black coal brought up from the pit. The South Manchuria Railway Company takes great pride in introducing and announcing the opening of its new Ryuho shaft mine, which together with the highly renowned open-cut mine, boosts still higher the name of Fushun.

China's Coal Production and Trade*

CHINA'S coal deposits, distributed in the provinces of Heilungkiang, Kirin, Liaoning, Jehol, Chahar, Suiyuan, Shansi, Hopei, Shantung, Honan, Shensi, Hupeh, Anhwei, Kiangsi, Chekiang, Kiangsu, Hunan, Szechuen, Yunnan, Kweichow, Kwangsi, Kwangtung, Fukien, Kansu, Ninghsia and Sinkiang, amount to 248,287,000,000 tons according to the estimate of the National Geological Survey, Ministry of Industry. This would rank China as third among the coal-bearing countries of the world, being next only to the United States and Canada. The following table shows the quantity (in 1,000,000 tons) of coal deposits in various Chinese provinces:

	Bituminous Coal	*Anthracite*	*Others*	*Total*
Heilungkiang	619	6	392	1,017
Liaoning	1,649	187	—	1,826
Chahar	487	17	—	504
Shansi	87,985	36,471	2,671	127,127
Shantung	1,613	26	—	1,639
Shensi	71,200	750	—	71,950
Anhwei	287	60	—	347
Chekiang	81	20	—	101
Hunan	338	255	—	4,000
Yunnan	1,485	11	131	1,627
Kwangsi	44	113	—	300
Fukien	—	51	—	500
Sinkiang	—	—	—	6,000
Kirin	986	2	155	1,143
Jehol	573	2	39	614
Suiyuan	337	58	22	417
Hopei	2,088	981	2	3,071
Honan	1,994	4,630	—	6,624
Hupeh	280	160	—	440
Kiangsi	765	204	—	969
Kiangsu	192	25	—	217
Szechuen	9,810	64	—	9,874
Kweichow	775	774	—	1,549
Kwangtung	371	50	—	421
Kansu, Ninghsia	—	—	—	6,000
Total	183,817	45,915	—	248,287

From the above table, it will be seen that deposits in Mongolia, Tsinghai and Tibet are not included. It also should be mentioned that deposits consisting of a coal stratum of less than a meter in thickness or situated more than 1,000 meters below the earth's surface are excluded in the estimate. The province of Shansi, containing about 60 per cent of the entire coal deposits in the country and 80 per cent of the entire anthracite deposits, may very well be regarded as the Saar of China.

Although China has rich coal deposits and a vast population, her annual coal production is insignificant, amounting to only 26,985,000 tons in 1932 according to the Shun Pao Year Book. Details of coal production in various provinces during the year are shown by the following table:

Liaoning	7,220,000	Kiangsi	450,000
Shansi	2,600,000	Szechuen	700,000
Chekiang	150,000	Suiyuan	90,000
Yunnan	100,000	Chahar	100,000
Jehol	380,000	Shantung	2,300,000
Hunan	1,000,000	Anhwei	350,000
Snensi	250,000	Kwangtung	300,000
Fukien	50,000	Honan	2,020,000
Sinkiang, Kansu	200,000	Kirin	500,000
Hopei	7,350,000	Hupeh	300,000
Heilungkiang	220,000	Kwangsi	100,000
Kiangsu	130,000	Ninghsia	5,000
Kweichow	120,000		
		Total	26,985,000

From the above table it is shown that the annual coal production of China amounts to less than one nine-thousandth of her deposits. The above figures, however, include the products of modern collieries only. There are a large number of coal mines in the country which are worked by old methods but, owing to the lack of authoritative statistics, it is almost impossible to know the amount of the products of these coal mines. According to some estimates, the total production from these native collieries is about 6,000,000 to 7,000,000 tons annually. Adding this amount to the products of the modern collieries, the total annual coal production of China in recent years may be approximately shown as follows:

	Coal Production (tons)		*Coal Production (tons)*
1921	20,459,000	1929	27,215,000
1922	25,781,000	1930	32,724,000
1923	24,172,000	1931	24,552,000
1924	26,037,000	1932	23,040,000
1925	28,378,000	1933	25,437,000
1926	21,097,000	1934	26,985,000
1927	24,255,000	1935	21,660,000
1928	25,092,000		

It will be seen that a rising trend was noticeable in the coal production of China during the period from 1921 to 1931, mainly due to the rapid development of several large collieries. The provinces of Liaoning, Hopei, Honan, Shansi, Shantung and Szechuen stood out as the most prominent in coal production, with Liaoning and Hopei taking the first and second places respectively. In 1931, the total coal production of China was about 12,000,000 tons, of which about 10,000,000 tons was bituminous coal, and about 1,500,000 tons, anthracite. The Kailan, Chunghsing and Luta of Poshan, collieries each produced over a million tons; the Tatung, Huainan, Liuhokou, Pinghsiang, Yili, Changhsing and Chingching collieries each produced from 200,000 to 700,000 tons, while other smaller collieries each produced less than 100,000 tons. The following table shows the annual production and sales of the several more important collieries in the country during 1931:

	Annual Production (tons)	*Annual Sales (tons)*
Kailan	4,343,000	4,120,000
Tatung	212,000	236,000
Huatung	321,000	220,000
Luta, Poshan	1,800,000	1,712,000
Yili	220,000	165,000
Huafeng	100,000	70,000
Paoheng	60,000	45,000
Pinghsiang	250,000	250,000
Mingseng, Honan	100,000	55,000
Chunghsing	1,296,000	1,290,000
Huainan	290,000	292,000
Changhsing	186,000	127,000
Liuhokou	570,000	550,000
Chingching	700,000	630,000
Hoseng	30,000	15,000
Paohsing	60,000	60,000
Hinshan	15,000	15,000
Shimenkou	52,000	50,000
Total	10,660,000	9,902,000

There are numerous trade names for various varieties of coal. Generally, however, they may be divided into two main kinds, anthracite and bituminous coal. The former is used by iron and steel works or in the household. Coal briquette, a very widely used fuel in China, is made of the dust of anthracite coal. China consumes annually a considerable quantity of anthracite coal. Shanghai alone imports about 150,000 tons annually, largely from French Indo-China (Hongay) and Japan, although several Chinese collieries, like Shansi, Honan, Mentoukou, Liukiang, etc., also produce some anthracite. Bituminous coal is the most important product of Chinese collieries and is produced by nearly every one of them. It is used for various industrial purposes, for steamships and railroads.

In China, perhaps the most serious problem confronting the production and marketing of coal is transportation. China is insignificant as a coal producer mainly because of the undeveloped state of her transportation system. The Ministry of Railways fixed freight rates for transporting coal on various lines.

Naturally, in addition to transportation on railways, coal is frequently carried by steamships. The freight rate for shipping coal on water routes is considerably lower than that charged by the railways, but as steamship services are not offered at regular intervals, much more time is required. The Kailan Administration, on account of the fact that it has its own coal ships, has a decided advantage over other Chinese collieries.

*Chinese Economic Journal and Bulletin for April, 1937.

During the last decade, owing to political disturbances in the country, most of the Chinese railways were frequently interrupted or even sometimes partially destroyed and Chinese coal has been thus frequently deprived of its chief means of transportation. Furthermore, the freight charged by railways adds heavily to the cost of coal. For instance, it costs more than seven dollars to transport a ton of coal from Kouchuan, Shansi, to the port of Tangku and six dollars from Chingching or Liuhokou to Hankow. The freight alone, not to say the mining costs, is already above the selling price of Japanese coal. In addition to the regular freight, Chinese railways usually make other miscellaneous charges on transporting coal. Some foreign-controlled collieries in China, however, enjoy special facilities in transportation on account of having extended loans to Chinese railways. The Peiping-Suiyuan Railway administration has constructed a branch into the coal mining district of the Sino-British Syndicate, while the Peiping-Liaoning Railway offers special rates to the Kailan mines.

According to the Mining Law now in force, two kinds of taxes, the mining district tax and an excise, are imposed upon the production of coal. In addition, a Customs duty and several other miscellaneous taxes have to be met. The mining district tax and the excise are not imposed at uniform rates, but vary with different collieries. On the whole, Chinese-owned collieries are placed under a much heavier tax burden than those controlled by foreign interests. For instance, the product of the Kailan Colliery is subject to a tax of only about 15 cents per ton, while many forms of taxes are imposed upon the Chinese coal mines. Very frequently, these miscellaneous taxes exceed considerably the amount of the mining district tax and the excise.

The products of Chinese collieries are sold on the market at prices usually higher than those of Fushun and Kailan coal. The mining cost of Chinese coal, however, is in no way higher. The higher prices are mainly caused by the high cost of transportation. The following tables show the mining cost of the products of Chinese collieries in various provinces.

	Mining Cost per ton		*Mining Cost per ton*
Kailan	$2.200	Fushun	$2.490
Chingching	2.250	Wuhutsui	5.000
Yili	2.650	Penchihu	5.500
Chungyuan	3.170	Yutung	4.500
Chunghsing	3.500	Chicheng	2.650
Potung	2.185	Huafeng	3.500
Linkiang	2.850	Fengkuanshan	1.800
Chengfeng	2.600	Shihmenkou	4.000
Mentoukou	2.400	Tatung, Paoching	2.600
Liuhokou	2.600	Chienchang	2.350
Luta	3.850	Yuanfeng	2.000
Yuehsheng	2.500	Tasing, Tahsing	4.250
Poping	2.900	Sian	4.500
Foukang	3.200	Pataohao	6.500
Huapao	6.520	Naitzushan	7.000
Huping	1.500	Moling	5.720
Chimenchiao	1.800	Hokang	5.310
Chinpei	2.600	Pinghsiang	6.300
Pingting, Paoching	2.900	Changhsing	3.600
Taiyuan	2.300	Huatung	5.800
Paohsing	2.200	Tatung	6.800
Fuyuan	5.000	Chasainor	4.000
Peipiao	3.500	Polo	5.000

From the above table, it is seen that the average mining cost of Chinese coal is about $3.80 per ton, while that of Japanese coal is about $4.00. However, owing to poorer transportation facilities and higher freight charges, Chinese coal is usually sold at higher prices even on home markets. Consequently, improvement of transportation and a reduction of freight rates are the prerequisites to the development of coal mining in this country, although other things, such as poor management, insufficient capital, frequent labor troubles and heavy taxation should also engage our attention.

In China, the price of coal is influenced by many factors besides the usual seasonal changes. As China does not produce sufficient coal for home consumption, considerable quantities of coal are imported into the various ports annually, and so the coal price is frequently affected by fluctuation on markets abroad. A disparity between supply and demand, caused by a sudden increase in production or an interruption of the communication system also causes fluctuations. The change in the value of gold, too, frequently exerts its influence. The high price of coal during 1929 was largely caused by the appreciation of gold value during that year.

The Kailan, Poshan, Chingching, Chunghsing, Tatung, Polo, Huainan and Liukiang collieries supply the bulk of the coal consumed in this country. In 1935 Shanghai consumed about three million tons of coal, of which about 42 per cent came from collieries along the Peiping-Liaoning Railway line; about 22 per cent, from those on the Kiaochow-Tsinan line; and 16 per cent from the Tientsin-Pukow line, the remaining 20 per cent being supplied by collieries of other places.

Tientsin is the second largest coal-consuming city in the country, using about 1,100,000 tons in 1935. About 55 per cent of the supply came from collieries along the Peiping-Liaoning Railway line, 25 per cent from those along the Chengting-Taiyuan Railway line, and 16 per cent from Mentoukou and Hsishan. Next to Tientsin came Peiping, consuming about 1,000,000 tons of coal in 1935. The bulk of the coal used, about 56 per cent was supplied by coal mines of Mentoukou and Hsishan, and about 25 per cent, from mines along the Peiping-Liaoning Railway line. The coal consumption of Hankow during 1935 was approximately 800,000 tons, of which the collieries along the Peiping-Hankow Railway line supplied 44 per cent; those on the Hupeh-Hunan Railway line, 19 per cent; those in the Yangtze Valley, also 19 per cent; and those along the Peiping-Liaoning line, 11 per cent. In 1934, Canton consumed about 560,000 tons of coal, of which 39 per cent came from mines along the Peiping-Liaoning Railway line; 25 per cent from those on the Canton-Shiukuan Railway line; the remaining portion being largely coal imported from French Indo-China, Netherlands India and other foreign collieries. Hongkong used more than 800,000 tons of coal in 1935. Only about 100,000 tons were supplied by Chinese collieries, the bulk being imported from abroad. The following table shows the amount of coal consumption in various important industrial centers of the country during 1935:

	Annual Consumption (tons)	*Principal Supplying Collieries*
Shanghai	2,800,000	Kailan
Tsingtao	600,000	Poshan, Luta
Tientsin	800,000	Kailan
Canton	600,000	
Amoy, Swatow, Foochow	300,000	
Pukow	700,000	Chunghsing
Hankow, Wuchang	660,000	Kailan, Pinghsing, Liuhokou
Wuhu	80,000	Tatung, Huainan
Tsinan	300,000	Poshan, Luta
Kaifeng	300,000	Pinghsiang, Liuhokou
Chengchow	100,000	
Anching	100,000	Tatung, Huainan
Pangpu	60,000	
Suchow	100,000	Chunghsing
Soochow, Wusih, Changchow, Kiangying, Chengkiang	400,000	Kailan, Chunghsing

Shanghai, being the principal commercial and industrial center of the country, consumed annually about three and a half million tons of coal, about one-seventh of the total consumption of the country, prior to 1931. The bulk of the coal consumed, however, was Japanese and Fushun, only about half a million tons being supplied by Chinese collieries.

In Shanghai, there are three kinds of concerns dealing in coal, namely, coal companies, coal firms and coal shops. The last named are very small in scale, each depending upon a single street or lane for its business and supplying household needs only. The mining companies do business on a large scale, but, as they are far surpassed in number by the coal firms which deal mainly in wholesale transactions, engage in retail business as well, these coal firms constitute the most prominent group in the coal trade of Shanghai. They buy coal from various collieries or their agencies, and some of them have concluded sales contracts with the mining companies.

China's total annual consumption of coal stood between 25 to 30 millions tons, and amounted to only 0.055 ton per capita, reflecting clearly the undeveloped state of China's industries and their slow progress. Industrial and commercial centers like Shanghai, Hankow, Dairen, Harbin and other cities along the sea coast and in the Yangtze Valley naturally consume a much larger quantity of coal than the interior regions, where the consumption of coal is less than 0.4 ton per capita.

According to some estimates, the total annual coal consumption in China is about 22 million tons. The northern provinces of Hopei, Honan, Shansi and Shantung produce considerably more coal than they can use locally, and the surplus is shipped to the South, mainly

to the coastal cities and regions in the Yangtze Valley. The following table shows the approximate quantity of coal consumed in various parts of China:

	Coal Consumption (1,000 Tons)
Northwest China	1,425
Southwest China	2,191
Northeast Hopei	889
Regions along Northern T.P.R.	1,406
Southern Shantung and Northern Kiangsu	389
Central and Northern Anhwei	209
Mengying, Linyi, Shantung	37
Honan	380
Peiping and Northwest Hopei	1,208
Regions along Peiping-Suiyuan Railway	534
Shantung Coastal Regions	64
Central and Northern Shantung	1,900
Central Hopei	1,000
Regions along Chengting-Taiyuan Railway	452
Northern Honan, Southern Hopei, Western Shantung	2,000
Central and Eastern Hupeh	982
Regions along Chuchow-Pinghsiang Railway	459
Western and Southern Hunan	514
Central Kiangsu and Southeast Anhwei	489
Fukien and Kwangtung Coastal Districts	913
Northern Kiangsi and Western Anhwei	62
Bordering Districts between Kiangsi, Fukien, Chekiang	64
Southeast Kiangsu and Northern Chekiang	3,596
Total	21,663

The coal produced in Jehol and Chahar is mainly the product of the Peipiao colliery and has Yingkow as its chief distribution center. The products of Tatung and Hsuanhua are mainly marketed in Tientsin and Peiping, though a portion is shipped to Shanghai and other southern cities. The Japanese-controlled colliery of Fushun supplies a considerable quantity of coal to Shantung, the Yangtze Valley and the coastal provinces in the southeast. The provinces of Hopei, Shantung, Shansi and Honan take little coal from outside. The Kailan Colliery of Hopei ships annually more than a million tons of coal to the Yangtze Valley, and about 300,000 tons to the southeastern provinces. During recent years, owing to the appreciation of gold value, Kailan coal has even found a market in the Three Eastern Provinces. Other collieries in these provinces, like Chunghsing, Poshan, Luta and Tzechuan, also supply considerable quantities of coal to Central and South China. The Changhsing Colliery of Chekiang ships a certain quantity of coal to Hankow besides supplying local demands. Generally speaking, the central and southern provinces do not produce sufficient coal for local use and have to ship about five million tons from the North annually. In recent years, as the surplus of coal in the northern provinces amounted to only about four million tons a year, foreign coal has been imported to make up the shortage.

Shanghai factories consume more than 20,000 tons of coal a day. In addition, other nearby cities such as Hangchow, Wusih, Soochow, etc., also obtain their coal supply from Shanghai. In recent years, owing to the general depression, many factories have closed down or suspended operation, and the consumption of coal has considerably fallen. This fact is clearly shown by the diminishing coal imports into the port of Shanghai since 1932.

According to some estimates, the total daily coal consumption of Shanghai factories amounted to more than 30,000 tons, of which the Huainan Colliery supplies about 10,000 tons; Huatung, 6,000 tons; Chunghsing, 10,000 tons; Tatung 6,000 tons; and Tatung 2,500 tons, the remaining portion being supplied by various other coal mining companies.

The following is a brief sketch of the markets of the principal collieries of various provinces:

Hopei—Undoubtedly, the Kailan Colliery is the largest of its kind in this province, producing annually more than five million tons of coal. It is not only the chief coal supplier of North China, but also ships considerable quantities of coal to Shanghai and other ports in the Yangtze Valley and the coastal regions of Fukien and Kwangtung. The following table shows the quantity of Kailan coal marketed in various parts of the country during 1935:

Japan and Korea	516,000	Lower Yangtze	192,000
North China	1,477,000	Hankow	132,000
Peiping	90,000	South China	217,000
Tientsin	879,000	Amoy	41,000
Tangku	173,000	Foochow	14,000
Chinwangtao	293,000	Swatow	19,000
Chefoo	42,000	Hongkong	93,000
Tsingtao	10,000	Canton	50,000
Central China	1,292,000	Other places	826,000
Shanghai	968,000		
		Total	4,328,000

The Chingching Colliery, with a daily production capacity of 5,000 tons, actually produces about 1,500,000 tons a year. Formerly the market for the products of this mine extended as far north as Peiping and Tientsin and as far south as Shanghai and Hankow. Recently, however, owing to various reasons, the market has shrunk and is now almost limited to Shenteh and Paoting; the daily production has also decreased to only about 1,500 tons. On account of higher cost of production, the products of this colliery compete unfavorably with those of Kailan.

The Chengfeng Colliery is better equipped than the Chingching, though having only about the same production capacity. Similarly, the market for its products has shrunk in recent years, being now almost confined to the neighboring localities. At present, it produces from 500 to 1,500 tons of coal a day.

The Liukiang Colliery had a quite extensive market, but, owing to the high cost of production, its products cannot compete favorably with those of Kailan. At present, it has been bought over by Kailan.

Honan—The Chungyuan Colliery, producing annually about 800,000 tons of anthracite, has enjoyed quite a profitable business during recent years. Owing to the high cost of production, amounting on the average to $3.64 per ton, this colliery has found it increasingly difficult to market its products. The products are rarely used in factories, but mainly for household consumption.

The Liuhokou Colliery has Hankow as its principal market and Shanghai as a minor market. As the cost of production amounts to as high as $3.50 per ton, sales have been shrinking during recent years, and large quantities of its products frequently accumulate unsold in Hankow.

Shantung—The Chunghsing Colliery is not only the largest in this province, but also one of the most prominent in the country, producing annually 800,000 tons of coal. About half of its products are sold to places along the Grand Canal and the Yangtze River and to the Tientsin-Pukow, Lung-Hai and Nanking-Shanghai railways. Owing to the good quality of its products, the business of this colliery has been on an upward trend. However, as the cost of production is high and in Shanghai no profit can be obtained unless the coal is sold at a price above $18 per ton, the company has found it difficult to compete with Kailan.

The Luta Colliery produces about 600,000 tons of coal a year. The bulk of its products is consumed by the Kiaochow-Tsinan Railway and in regions along that line; only about 200,000 tons are annually shipped to other places through Tsingtao.

The Potung Colliery produces about 80,000 tons of coal annually. Owing to the good quality of its products, its market is now no longer limited to regions along the Kiaochow-Tsinan Railway, but has extended to Shanghai and other places in the South. The company, however, has contracted with a Japanese firm to sell coal to the latter at fixed prices and thus the colliery has not made as much profit as it might.

The Yuehsheng Colliery has a daily production capacity of about 550 tons. Besides supplying local needs, its products are shipped to Tsingtao, Tsinan, Shanghai and other places in the Yangtze Valley.

There are a number of smaller collieries in the province, each having a daily capacity of from 70 to 250 tons. Their products are mainly sold locally.

Shansi—The province of Shansi has long been noted for its rich coal deposits. On account of the facilities offered by the Peiping-Suiyuan Railway, Kouchuan has become the chief center of distribution for the coal produced in the northern parts of the province. The products of collieries in northern Shansi are good for all industrial uses owing to their superior quality. On account of poor management and high cost of transportation, however, no great development has taken place during recent years. It cost more than $8 to ship a ton of coal from northern Shansi to Shanghai and from $5 to $6 to Tientsin. The Tatung Mining Company is an organization formed by the Peikuang, Paoching and Tungpao collieries. A strict quota system is laid down for every sale made by the Company. The principal markets are Tientsin, Peiping, Nanking and Shanghai.

Kiangsi—This province produces annually about 400,000 tons of coal, of which about 25,000 tons come from the Pinghsiang Colliery; 20,000 tons from the Polo Colliery; and 10,000 tons from the Fengcheng Colliery. The coal mines in the districts of Chingyen, Chungjen, and Chian produce about 50,000 tons each annually. The Pinghsiang Colliery, enjoying transportation facilities offered

by the Chuchow-Pinghsiang Railway and the thirty or more steamboats of its own, can easily ship its products to Yochow, Chuchow and other places along the Hankow-Canton Railway. Upon the completion of the Yushan-Pinghsiang Railway, the mine will be linked to the main line of the Hangchow-Kiangshan Railway and thus secure a much wider market. Formerly, the Pinghsiang Colliery produced a very large quantity of coke for the use of the Hanyang Iron Works. Since the iron works suspended operations, the production of coke has decreased to less than 600 tons a day.

Hunan—Coal mining is still in an undeveloped state in this province. The bulk of the products of Hunan collieries is locally consumed. The Yi Chi Colliery of Liling, however, sells its products chiefly in Hankow, with Changsha as a subsidiary market. The Shihmenkou Colliery of the same district ships its products to Hsiangtan, Chuchow and Changsha besides supplying local needs. The principal markets of the coal produced by the Chicheng Colliery of Hsianghsiang are Hankow, Changsha and Hsiangtan. The products of other collieries in the province are mostly consumed locally.

Anhwei—The Lishan Colliery produces about 120,000 tons of coal annually, of which 30,000 tons are consumed locally and 70,000 tons in regions along the Tientsin-Pukow Railway, only a small portion being shipped to Shanghai. The Lishan fuel coal, owing to its high cost of production, cannot be disposed of profitably in Shanghai unless at prices above $13.60 per ton, and it is therefore unable to compete on Shanghai market with the Hongay coal imported from Indo-China. The Mantoushan Colliery of the district of Kueichi produces about 60,000 tons of coal a year. Anching, Wuhu and Chingkiang are the principal markets for the products of this mine. In Shanghai, owing to its poor quality and high cost, Mantoushan coal competes unfavorably with Hongay coal.

Kiangsu—The Chiawang Colliery had an annual production of nearly 200,000 tons, but recently the production has greatly decreased. Its products are largely marketed in regions along the Tientsin-Pukow and Lung-Hai railways and Ningpo and Shanghai.

Chekiang—In recent years, there has been rapid industrial growth in the city of Hangchow and at present this city consumes about 10,000 tons of coal a month. Of this quantity, about 60 per cent is anthracite supplied by collieries of Honan and Shansi, the remaining 40 per cent being bituminous coal from the collieries of Shantung, Hopei and Anhwei. In addition, several hundred tons of coke is used by iron works in the city every month. During past years, the use of coal has extended to the neighboring districts and the demand for coal has become still larger. The Changhsing Colliery is the only large-scale colliery in the province, producing about 500 tons of coal daily. There is a light railway connecting the coal fields with Wulichiao, and the colliery owns a number of steamboats and coal barges. Consequently, this colliery enjoys quite good communication facilities. Its products are mainly consumed by the factories of Wusih, Chiahsing and Soochow, as, for financial reasons, the company has concluded sales contracts with those factories ; so only a little of their coal is left to be marketed in Hangchow. In Shanghai, too, although the company has established a warehouse there, business does not amount to much on account of keen competition.

Generally speaking, the coal market of China is still largely under foreign influence. Nearly 80 per cent of the coal consumed in Shanghai, the largest coal-consuming city in the country, is either directly imported from Japan, French Indo-China and British India or supplied by foreign-controlled collieries in China, such as Fushun, Kailan and Chefoo. About 60 per cent of the coal consumed in Tientsin is supplied by the Kailan Colliery, and even Hankow uses largely the products of this British-owned colliery. Canton, too, imports annually about 200,000 tons of foreign coal. As a result of the predominance of foreign coal in most commercial ports, the products of Chinese collieries are largely marketed in regions along various railways. Those of the Liukiang and Chancheng collieries are marketed in regions along the Peiping-Liaoning Railway ; those of Lincheng, Chengfeng, Yili, Chungho, etc., in regions along the Peiping-Hankow Railway ; those of Chungyuan, Liuhokou and Mingseng, in regions along the Lunghai Railway ; those of Chunghsing, Lishan, Tatung, Huainan and Chiawang, in various sections of the Tientsin-Pukow Railway ; those of Chingpei and Paoching, in regions along Peiping-Suiyuan and Chengting-Taiyuan Railways. In a word, most of the Chinese collieries depend upon interior regions as their principal markets.

According to Customs reports, the total annual coal imports during years prior to 1921 amounted to about a million tons worth about Hk.Tls. 10,000,000 and coal exports to about 1,200,000 or 1,300,000 tons, worth about Hk.Tls. 13,000,000 or Hk.Tls. 14,000,000. After 1921, the volume of both imports and exports grew steadily until 1931, after which year, a downward trend was seen. The following table shows the value and quantity of annual imports and exports during past years :

	Exports		*Imports*	
	Quantity (tons)	*Value (Hk. Tls.)*	*Quantity (tons)*	*Value (Hk. Tls.)*
1922	2,421,828	15,385,041	1,153,472	11,347,528
1923	3,138,006	20,905,064	1,382,161	13,481,990
1924	3,229,522	20,859,806	1,667,409	16,062,328
1925	3,021,739	20,258,052	2,757,708	26,779,335
1926	3,099,043	26,397,122	2,902,451	28,016,304
1927	4,026,811	29,574,352	2,324,209	22,998,804
1928	3,899,245	28,422,679	2,432,932	23,330,471
1929	4,136,535	31,079,274	2,286,167	19,543,561
1930	3,515,571	27,268,442	2,473,945	25,592,229
1931	3,591,052	31,164,368	1,909,155	21,886,990
1932	2,119,630	12,159,104	1,424,133	13,227,707
1933	575,011	3,281,411	1,978,658*	22,264,513†
1934	811,996*	6,287,415†	1,038,436*	11,115,654†
1935	774,441*	8,292,865†	877,130*	6,597,502†
1936	560,687*	6,442,434†	1,374,942*	11,025,341†

The products of the Kailan and Fushun collieries constitute the bulk of coal exports from China amounting to nearly 70 per cent of the total, with those of Shantung and Penchihu next. Inward coal shipments consist largely of products from Japan and French Indo-China. Peipiao coal, that is, the coal from Jehol and Chahar, has been exported in increasing volume during recent years. Outward shipments of coal from Tsingtao also registered an upward tendency. After 1932, however, owing to the occupation of the Three Eastern Provinces, a great drop was seen in the volume of coal exports as shown by the Customs reports.

Prior to 1921, Chinwangtao, Dairen, Tientsin, Antung and Kiaochow were the principal coal exporting ports. After that year, conditions changed somewhat. Antung, Dairen and Kiaochow became the most important ports for the exportation of coal, with Chinwangtao, Newchwang, Tientsin, Changsha and Hankow next in order. The following table shows the quantity (in tons) of coal exports from various Chinese ports during past years :

	1931	*1932*	*1933*	*1934*	*1935*
Chinwangtao ..	2,471,579	339,475	447,294	690,841	639,165
Tientsin	230,162	24,542	24,097	12,857	26,135
Kiaochow	322,256	86,595	63,367	74,347	86,919
Changsha	17,115	32,562	—	—	—
Hankow	3,401	21,153	—	—	4,069
Shanghai	2,732,939	11,541	35,891	20,510	81,378
Nanking	24,362	192,362	—	13,119	39,186

The coal exported from China goes largely to Japan and Formosa, annual shipments usually amounting to more than two million tons. Hongkong and the Philippines, each absorbing about 200,000 tons annually, are next in importance. The following table shows the quantity of coal exported to various countries during past years :

	1931	*1932*	*1933*	*1934*	*1935*
Hongkong	305,514	232,483	81,870	47,676	70,701
Great Britain ..	51	25,043	5,717	52	4,273
Germany	898	19,050	11,111	16,000	32,284
Korea	351,600	216,966	47,471	138,778	49,682
Japan and Formosa.	2,151,483	1,490,686	386,061	568,163	615,745
The Philippines ..	139,070	62,952	7,661	1,475	8,496
U.S.A.	3,635	8,479	2,725	1,261	2,287

From the above table, it can be seen that after 1931, there was a general decrease in the volume of coal exports from China. On account of the general depression in recent years, the world's consumption of coal has been falling quite noticeably. It is only natural, therefore, that coal exports from China show a marked decline in volume.

Japanese coal constitutes the bulk of coal imported into China, with that of U.S.S.R., British India, and Java ranking next. As these countries are near, it does not cost much to ship their surplus coal to China. The Philippines, and the Straits Settlements, though no less proximate, ship only a little coal to this country, as they do not produce sufficient coal for their own use. Other coal-producing countries like Great Britain, Germany, Poland, Czechoslovakia and the United States, though having large quantities of surplus, sell

*Metric tons
†Dollars

largely to Southern European, African and South American countries; only about 100,000 tons are shipped annually to their colonies like the Philippines, British India, etc. Consequently, Japan and French Indo-China remain the principal coal-supplying countries to China.

Coal is the principal mineral product of the coastal regions of French Indo-China. Annually, coal exports from that country amount to more than a million tons. In 1913, coal shipments from Indo-China to this country amounted to over 200,000 tons, representing nearly 12 per cent of China's total coal import for the year. During the Great War and a few years immediately after it, a decline was seen in the volume of coal imported from French Indo-China. A recovery was, however, soon brought about, and in 1924, the quantity of coal imported from that country rose to 600,000 tons. During the last few years, although the volume of imports has diminished somewhat, coal from French Indo-China still kept its prominent position among imports into China. Japan formerly occupied the leading position in China's coal trade, but imports from that country seemed to show a decline during recent years. The following table shows the quantity (in tons) of coal imports from various countries during past years:

From	*1931*	*1932*	*1933*	*1934*	*1935*	*1936*
Japan	883,237	402,642	573,926	321,602	176,512	95,276
French Indo-China ..	527,067	475,318	474,238	269,359	245,432	301,617
Java	—	—	115,702	71,685	—	—
British India	13,727	211,739	164,650	63,310	49,915	8,277
Hongkong	175,042	57,546	18,627	3,602	365	3,719
Kwantung Leased Territory	—	59,774	462,119	230,529	154,662	87,965
Formosa	63,947	24,414	61,118	36,734	49,640	24,718

During the 13-year period from 1913 to 1925, the total annual amount of coal imported into this country was about 1,400,000 tons on the average, there being little marked rise or drop. From 1926 to 1932 the annual average was about 2,400,000 tons, showing an increase of nearly 75 per cent as compared with that of the previous period. A decline, however, was seen in the last few years. Japanese coal has always occupied a leading position in Chinese coal imports, but, during recent years, owing to the advance made by coal from the U.S.S.R., and French Indo-China, it has lost some of its prominence. Still, coal from Japan is imported into this country in quite considerable quantities, amounting to more than 300,000 tons in 1936 (including the products of Kwantung Leased Territory and Formosa).

The Yangtze Valley and Kwangtung are the regions in which the bulk of imported coal is consumed. The Yangtze Valley imports largely Japanese coal while Kwangtung absorbs mainly the anthracite from French Indo-China. The following table shows the quantity (in tons) of coal imported into various Chinese ports during past years:

	1931	*1932*	*1933*	*1934*	*1935*
Chinkiang	85,707	51,404	37,543	18,332	18,782
Shanghai	824,201	628,427	1,218,950	607,846	381,416
Swatow	89,218	92,036	65,187	42,348	37,904
Canton	256,214	348,984	271,549	137,654	138,036
Kowloon	78,741	97,137	74,466	30,353	36,341
Chefoo	—	—	61,420	41,955	38,737
Lungkou	2	3,068	30,033	42,139	36,341
Amoy	30,649	32,387	31,964	29,201	26,805
Hankow	17,151	35,407	43,001	2,836	7,427
Kiaochow	2,500	15,158	47,114	24,214	6,495

Shanghai, being the chief industrial center in the country, consumes a large quantity of coal. As this port and its surrounding country produce no coal, the coal supply of Shanghai is dependent upon collieries in North China and Japan. Japanese coal usually represented about 45 per cent of the coal shipped to Shanghai. In recent years, owing to the keen competition of the products of such collieries as Kailan, Chunghsing and Huatung, etc., and the increase of the import tariff rate on coal in 1934, coal shipments from Japan to Shanghai have considerably declined in volume. The following table shows the total quantity of coal shipped to Shanghai, and that from Japan:

	Total Coal Imports of Shanghai (tons)	*Coal Import from Japan (tons)*	*Coal Import from Fushun (tons)*
1930	3,691,843	859,738	744,353
1931	3,616,900	638,100	699,000
1932	2,942,350	372,800	376,550
1933	3,322,700	507,000	430,000
1934	3,228,800	260,800	182,000
1935	774,441*	176,512*	135,600*

*Metric tons

From the above table, it is seen that prior to 1930, Japanese and Fushun coal amounted to more than half of total coal shipments to Shanghai. Since that year, however, a steady decline has been seen. In 1934, Japanese coal amounted to only one-eighth of the total import to Shanghai. This fact was mainly caused by the increase in tariff rates and the development of Chinese collieries in North China. The following table shows the quantity (in tons) of coal shipments to Shanghai from various sources during past years:

	1933	*1934*	*1935*
Kailan	1,120,400	1,159,100	1,022,600
Chunghsing	193,600	393,700	397,500
Shantung	446,900	537,200	540,000
Shansi	106,100	197,700	160,000
Other Collieries in China	312,100	365,900	385,600
French Indo-China (anthracite)	206,600	132,400	112,800
Japan	507,000	260,800	164,700
Fushun	430,000	182,000	135,600
Total	3,322,700	3,228,800	2,969,200

Prince Chichibu Visits British Metals Plant

H.I.H. Prince Chichibu of Japan visited the Kynoch Works of I.C.I. Metals, Ltd., at Witton, Birmingham, in July. He was accompanied by Lord McGowan, Chairman of Imperial Chemical Industries, Ltd.; Mr. George Sale; Mr. H. O. Smith, a Director of I.C.I.; Mr. A. J. G. Smout, who is in charge of I.C.I.'s operations in Birmingham; and Hon. H. W. McGowan.

At the Kynoch Works, where more than seven thousand people are employed, the Prince was shown some of the most up-to-date machinery in the British non-ferrous metal industry. Here, for example, melting in coke-fired furnaces is obsolete, the factory being the first in Great Britain to install leectric furnaces. Products range from a firebox plate, such as the one supplied for the L.M.S. Coronation train, weighing perhaps three tons, to a cartridge, which involves no fewer than 120 manufacturing operations, yet sells retail at a fraction over a penny.

The party visited the foundry and rolling mill. Here charges weighing nearly half a ton are melted in electric furnaces and the ingots passed to the rolls of a large reversing mill, which is probably the largest of its kind for rolling non-ferrous metals. Red-hot, they are reduced in thickness by successive passes through the rolls. After annealing and further rolling and annealing, the metal is delivered in strip to the warehouses.

The "Lightning" fastener machines, constructed in the Kynoch workshops, are most intricate and ingenious. The slide fastener produced is distinct from other I.C.I. metals products in its use by various trades not otherwise metal consumers. Though there are many types, it consists essentially of interlocking parts fastened to tapes and drawn together by a slider. The parts are metal, or may now be made of a plastic material.

The rapidly increasing demand for rod in copper, brass and the usual alloys has necessitated the building of a new rod mill, in equipment and size the most remarkable in the industry. Electric furnaces are again used for melting, but the moulds produce a round billet instead of the rectangular shape produced for strip manufacture. Cut into lengths by circular saws, the billets are brought to red-heat and in the extrusion press forced by a hydraulic ram against a steel die, to emerge as rod.

At least 200 types of cartridge case and 700 types of bullet are dealt with. For shotgun cartridge cases, the paper cases, the wads, steel, reinforced brass heads, anvils, cap chambers and heads are assembled entirely by machinery. In the loading field machines of uncanny manipulation and more than human accuracy weigh out and deliver shot charges and powder charges, insert the wads, close the case, gauge for length, diameter and other essential points, and weigh the cartridge.

The party, which included the Lord Mayor and Town Clerk of Birmingham and many leading industrialists, was afterwards entertained at a private luncheon by Lord McGowan.—*Eastern Engineering and Commerce.*

Wood-Block Paving in the British Municipal Area at Tientsin

By C. N. JOYNER, Deputy Municipal Engineer, Public Works Department, British Municipal Council, Tientsin; in the Journal of the Association of Chinese and American Engineers

THE problem of road paving in Tientsin is complicated by the wide variety of vehicles using the municipal roads. Ranging from the antique wheelbarrow to the modern heavy-weight motor truck, the vehicles found on our roads combine to present every type of wear and pressure upon the road surfaces. The principal factor damaging all types of road surfaces is the native steel-tired cart. These carts are familiar to everyone on the China coast, ranging from a country cart with a narrow tire having a concave surface, and often not exceeding 1½-in., to a modern type having a flat tire 4-in. broad. These broader tires have been introduced due to the restrictive regulations of the various foreign municipalities, but all of the steel-tired vehicles have produced excessive wear on the road surfaces.

With the introduction of pneumatic tires, the old-fashioned water-bound macadam, which had given excellent service for many years, became almost instantly obsolete and years of experiments have led to the adoption of only one type of road surfacing which can be said to be satisfactory under the impact of any large proportion of steel-tired traffic. The experiments have included asphaltic-concrete of several grades, sheet-asphalt, several types of vitrified paving blocks, reinforced asphaltic-concrete, wood blocks, cast-iron blocks, and reinforced concrete.

The reinforced asphaltic-concrete is laid with a patented reinforcement brought out from England, consisting of a mesh of mild steel strips so laid in the top course of asphaltic-concrete that the traffic bears directly on the edge of the strips. It produces an excellent surface which wears slowly and evenly. The main objection to this type is its excessive cost.

The reinforced concrete has been of all the ordinary types, as well as mixtures made of special hardening cements, as well as metallic fillers and with several types of aggregate. None of them have been satisfactory, all disintegrating under the grind and pound of steel tires.

The vitrified paving blocks produced in this province are of excellent quality, comparing quite favorably with those produced abroad. Laid with great care on several types of base, they have proved useful only where not exposed to the destructive steel tires. Under these tires, the bricks quickly shed their vitrified armor, and disintegrate in one or two seasons.

Granite blocks have been used at points of excessive traffic concentration in other parts of Tientsin, but have never been used in the British Area. This is due to the lack of a local supply and the very high cost of imported blocks.

A single experimental section of cast-iron blocks was put down on the Bund some years ago, and has given excellent results. When laid these blocks cost about ten times the price of wooden blocks. Since that time, world conditions have caused an even larger ratio between the prices.

In 1929 experimental stretches of wood blocks were put down, which gave results much more satisfactory than any of the other types of pavement, and after a four-year trial on the Bund, where the steel-tired traffic is particularly concentrated, the trial patches were found sufficiently satisfactory to justify the paving of the whole Bund frontage with this type.

The various types of pitch, creosote and asphalt treatment for wood blocks, have produced such poor results that in America and Europe the use of wood blocks has been abandoned almost entirely, the abandonment being attributed almost invariably to the displacement of blocks subsequent to the absorption of moisture. The climate of Tientsin, nine or ten months of the year, is excessively dry but there is a rainy season usually two or three months in the middle of summer, so that the problem of keeping moisture out of the blocks is substantially the same one as is met abroad. In Tientsin, the most successful wood blocks have been laid in an asphalt-sand mastic from ½-in. to ¾-in. thick on a reinforced-concrete foundation. It was found that laying blocks in the old-fashioned sand cushion produced a very smooth road surface but led to steaming and subsequent expansion and displacement of blocks when wet weather was followed by high temperatures. This difficulty is entirely eliminated when properly treated blocks are laid on the mastic base.

The most successful stretches of pavement have now been in use for four years, and have required approximately one per cent maintenance per year during that period, and do not yet show excessive wear. They were cut from planks of Oregon pine 8-in. wide and 3-in. thick in blocks 4-in. deep. These blocks were stacked in open tiers and permitted to dry as thoroughly as possible in the open air. At Tientsin, during autumn, winter and spring, this produces a very dry block but, undoubtedly, in other climates it would be necessary to kiln-dry the blocks. This preliminary open-air drying was originally followed by treatment on hot sand which treatment has now been dropped, not being necessary in this climate.

The thoroughly dried blocks are dipped in an open boiler containing asphalt at a temperature of from 300 deg. to 350 deg. Fahrenheit, care being taken to see that the temperature stays in this range and does not rise dangerously near the flash point of the bitumen. This treatment is continued for a period of not less than one hour. The blocks are then withdrawn and laid on a screen above the boiler so that surplus asphalt drains back into the boiler. The high temperature of the asphalt bath apparently drives off a considerable amount of air and some moisture from the blocks and the subsequent cooling permits the asphalt to enter the fibers from ¼-in. to ½-in. and effectively seals all openings.

Asphalt used has been of a penetration of from 45 deg. to 55 deg. of the type ordinarily used for sheet asphalt or asphaltic-concrete mixtures. It is possible that in more rigorous climates a higher penetration bitumen, ranging up to 60 or 70 penetration could be used successfully. These blocks are laid on a sheet asphalt mastic, spread on the concrete foundation, care being taken to prevent any great variation in the depth of sheet asphalt, which presupposes a fairly even concrete foundation. The mastic is mixed at a central depot, where possible, but may be hand mixed on hot pans on the job where small quantities are required.

The experimental areas of this type of block were dipped on two sides with plain asphalt. It was found, however, that with the cheap labor available in this district, it is possible to lay the blocks very much as a mason lays bricks in mortar by applying hot sheet asphalt with a trowel to one end and one side of the block. It is then rammed into place with a wooden mallet and all surplus material struck off. Great care must be taken to see that the joint is thoroughly filled with the sheet asphalt, and any small cavities should be pointed precisely as in laying ordinary masonry.

It is important to use a system of transverse and longitudinal straight edges and camber boards to secure an even surface. After laying, the surface is rolled with seven ton steam-rollers and 45 to 55 penetration asphalt is squeeged over the surface at a temperature of between 300 deg. and 350 deg. It is spread as thinly as possible and immediately blinded with stone dust of fine sand. The road may be opened to traffic at once.

The cost of this type of paving in Tientsin, exclusive of the concrete foundation, is approximately $5 per yard, being about the same as the cost of laying vitrified block and giving at least three times the life of vitrified block under local traffic conditions.

Engineering Notes

RAILWAYS

RAILWAY BOGIES.—Five underframes and bogies for carriages are being constructed for the Federated Malay States Railways by the Birmingham Railway Carriage and Wagon Co., Ltd.

NANKING-KIANGSI RAILWAY.—Rapid progress is being made in the construction of the Nanking-Kiangsi Railway. 300,000 sleepers ordered from the lumber mills in southern Anhwei have already been received, while many more from England and the United States will arrive by the end of the year.

THROUGH RAILWAY TRANSPORTATION.—The through railway transportation of freight between Japan and China was effected sometime ago, the negotations between the two countries long pending since 1915 having finally borne fruit. Through transportation will be applied to a single route, i.e., from Japan proper to Chosen to the stations on the Peiping-Shanhaikuan Railway.

RAILWAY ORDER.—To the Canton-Hankow Railway Messrs. Dobbie, McInnes and Clyde, Ltd., Glasgow, are supplying three sets of locomotive cylinder indicators, the Morgan Crucible Co., Ltd., Battersea, S.W. 11, a tilting furnace and Messrs. T. Robinson and Son, Ltd., Rochdale, a universal woodworker and 36-in. band saw. A complete set of mechanical and electrical signalling apparatus for Hengchow station is on order with the Westinghouse Brake and Signal Co., Ltd., Chippenham, Wilts.

SHANGHAI-CANTON LINE.—Through railway traffic between Shanghai and Canton will be inaugurated by the Ministry of Railways on November 1, instead of next spring, in order to meet the public's wishes. A meeting of the responsible officials of the Shanghai-Hangchow-Ningpo, Chekiang-Kiangsi and Canton-Hankow Railways was convened by the Ministry yesterday when measures regarding the co-ordination of the three lines as regards locomotives, traffic and operation were discussed.

18 NEW RAILWAY LINES.—The authorities of the Railway Ministry have tentatively decided on the construction of 18 new railway lines in the Tohoku district—comprising Yamagata, Akita, Aomori, Iwate, Miyagi and Fukushima prefectures—in the next seven fiscal years. The requirements of national defence and economic development of the area are said to have been taken into consideration.

Work would start in the coming fiscal year and be completed in the 1942-43 fiscal year, by which time between Y.80,000,000 and Y.90,000,000 would have been expended. The new program is expected to increase to Y.45,000,000 the annual appropriation for railway construction, for the old construction program will not be completed until the 1941-42 fiscal year.

SHIPPING

"ZENYO MARU."—The Toyo Kisen Kaisha are the owners of M.S. *Zenyo Maru*, one of two 9,500-ton ships being built for them by the Mitsubishi Dockyard. The *Zenyo Maru* is 436-ft. 3-in. long with a beam of 58-ft. 3-in., and will be equipped with a two-cycle double-acting Mitsubishi engine.

NEW YORK—FAR EAST SERVICE.—Three similar ships to the *Grete Maersk* are, it is stated, to be laid down at the Bremer Vulkan yard for A. P. Moller, designed for service between New York and the Far East. They are of 9,200 tons d.w.c. and have twin-screw double-acting M.A.N. machinery of about 8,400 h.p., the service speed being 16 knots.

MORE JAPANESE FREIGHTERS.—Japanese shipowners have been requested to put more ships on lines to India and other South-Sea countries so as to secure a smoother supply of pig-iron and other raw materials from those countries. The Ministry of Communications has put this advice to the Association of Shipowners, and it is likely that it will be followed. At the same time the Association is studying how to overcome the growing shortage of bottoms by exercising voluntary control of the shipping industry, possibly through a pool for the operation of freighters, both liners and tramps.

The Osaka Shosen Kaisha, Japan's second largest shipping company, contemplates starting a direct South American service via the Panama Canal, with four vessels. One ship has already been put on the South American line and another, the *Hakonesan Maru* (6,800 tons) is sailing from Yokohama on July 7.

MOTOR CARGO VESSELS.—The N.Y.K. has had three motor cargo ships on order with the Mitsubishi Jukogyo Kaisha for some time, similar to the *Akagi Maru*.

The same builders have now received an order for seven more cargo vessels from the N.Y.K. of a much improved *Akagi Maru* class, somewhat larger, with higher power and twin-screw machinery instead of a single engine. The length is 145 meters (476-ft.), the beam 19 meters (62.4-ft.), the depth 12.5 meters (41-ft.), and the draught loaded 8.4 meters (27.5-ft.). The gross tonnage is 7,100, the deadweight capacity 9,300 tons, and two Mitsubishi single-acting two-stroke engines will be installed, developing a total of 9,600 h.p. to give a service speed when loaded of 16 knots. It has not been decided upon which route these ships will be employed.

"KIMIKAWA MARU."—The single-screw M.S. *Kimikawa Maru* has a length of 475-ft. 7-in., a beam of 62-ft. 3-in., and carries 9,300 tons of cargo. The propelling machinery will consist of a 7,600 b.h.p. Kawasaki-M.A.N. double-acting two-cycle engine of the seven-cylinder type. The ship is under construction at the Kawasaki Dockyard for the Kawasaki Kisen Kaisha.

NEW MOTOR SHIPS.—The motor ships which are now being built for Mr. A. P. Moller for the Isbrandtsen-Moller Far East service should be able to compete successfully with the numerous modern cargo liners which the Japanese have utilized on this trade for the past few years, and those are now on order. The first two vessels, *Grete Maersk* and *Marchen Maersk*, are on their maiden voyages and they represent a very advanced class of cargo liner. They carry about 9,200 tons and should be able to maintain 16 knots in service when fully laden with their 6,800 b.h.p. machinery. Although only 12 passengers are carried, each stateroom has a private bathroom, and the cargo hatches are specially large to enable a cargo of big dimensions to be handled, even including aeroplanes. A 60-ton lift can be dealt with and, in addition to much refrigerated space in the ships, provision is made for carrying vegetable oil.

MINING

RARE METALS IN U.S.S.R.—A fivefold increase in the output of rare metals is planned by the Soviet Rare Metals Industry at the end of the Third Five-Year Plan (in 1942). By that time, too, ore concentration processes and mining operations should be completely mechanized, and production costs reduced. During the Five-Year Plan, it is hoped to meet the full requirements of the home market in basic rare metals, such as tungsten, molybdenum and mercury. Among the new metals to be mined are niobium, zirconium and rare elements like indium, germanium, etc.

NEW GOLD MINING CENTER.—According to Soviet advices a big gold mining center has been created in the heart of the Kazakh steppes, at the Maikain mine, some 65 miles from Pavlodar. Employing only 300 workers eighteen months ago, the mine now has 5,000 workers. A large settlement has sprung up in the neighborhood with all the amenities for a social and cultural life—a hospital, clubhouse, cinema, schools, creches, shops, miners cottages and so on. Both gold and silver are obtained from the brown hematite ore, which lies very near the surface. The Maikain district is very rich in minerals. In addition to gold and silver are polymetallic ores, quarry-stone, limestone, fire proof clay, brown coal and coal suitable for coking. Maikain now has two small amalgam works; another with a capacity of 1,000 tons a day is being planned. Plans are also being made to sink a big new mine, which will be entirely mechanized, and to erect an electric power station.